



29 March 2013

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SUBJECT: AFCEC 4P08 FA8903-08-D-8769; Task Order 0337  
MMR SPEIM/LTM/O&M Program  
CDRL #A001j  
**Fuel Spill-12 2012 Summary Letter Report**

Dear Mr. Davis:

The purpose of this Summary Letter Report (SLR) is to document the results of sampling activities conducted at the Fuel Spill-12 (FS-12) plume under the System Performance and Ecological Impact Monitoring (SPEIM) program during the 2012 calendar year. This deliverable contains no detailed assessment or evaluation of the results, but is a means of documenting all the actions completed under the FS-12 SPEIM program. The data collected under the SPEIM program are continually assessed and the results of these assessments are presented initially during the Technical Update Meetings and then through Technical Memoranda or Project Note deliverables, if warranted, based on the results of the data evaluation or to address particular plume issues.

In October 2012, the Air Force Center for Engineering and the Environment (AFCEE) adopted a new organizational name, the Air Force Civil Engineer Center (AFCEC). Therefore, the AFCEE and AFCEC acronyms refer to the same entity, but are used in this document in relation to the date of a specific topic or document.

This letter report includes a summary of the activities performed and the data collected for the FS-12 SPEIM program between 01 January 2012 and 31 December 2012. The contaminants of concern (COCs) for the FS-12 plume are ethylene dibromide (EDB) and benzene. Benzene has not been detected at a concentration above the Maximum Contaminant Level (MCL) of 5 micrograms per liter ( $\mu\text{g/L}$ ) at any monitoring well since 2007. Therefore, the FS-12 plume is defined by groundwater containing EDB at concentrations above the Massachusetts Maximum Contaminant Level (MMCL) of  $0.02 \mu\text{g/L}$ . The FS-12 extraction, treatment, and reinjection (ETR) system began operation in September 1997 with a design flow rate of 772 gallons per minute (gpm) from a total of 25 operating extraction wells. The treated water was then returned to the

aquifer through 22 reinjection wells. Since that time, the ETR system has been optimized several times. During 2012, the FS-12 ETR system operated using pumping configuration 2010 Scenario 01, which consisted of four operating extraction wells pumping at a combined total flow rate of 360 gpm (AFCEE 2010).

The extracted groundwater is conveyed to the FS-12 treatment plant where it is treated by a granular activated carbon system, combined with the J-3 range groundwater treatment system effluent, and returned to the aquifer via 12 of the 22 FS-12 reinjection wells. The J-3 range groundwater treatment system is a separate treatment train that is located within the FS-12 treatment facility and is owned and operated by the Impact Area Groundwater Study Program. The FS-12 plume, source area and treatment system are presented on [Figure 1](#).

AFCEE installed and operated the FS-12 ETR system as an interim response action, which, along with land use controls (LUC) became the selected remedy as documented in the Final Record of Decision (AFCEE 2006). A Final Explanation of Significant Differences was submitted in September 2011 that clarified the inclusion of monitored natural attenuation as a component of the selected remedy, slightly modified the phrasing of the remedial action objectives, added the well verification process associated with the LUC program, and updated the steps to achieve site closure (i.e., the three step process) (AFCEE 2011b).

## **FS-12 SPEIM ACTIVITIES**

The SPEIM program was developed to monitor plume changes and to ensure the effective operation of the AFCEC groundwater remediation systems at the Massachusetts Military Reservation (MMR). These objectives are met through monitoring of selected media (i.e., groundwater, surface water) within and outside the plume boundaries, treatment plant monitoring, and groundwater flow and transport modeling. Activities completed for the FS-12 SPEIM program during 2012 include the following:

### **SPEIM Sampling Activities:**

- Annual groundwater sampling (September 2012)
- Semiannual sampling of operating extraction wells (April and September 2012)
- Monthly treatment plant sampling (January 2012 through December 2012)
- Recreational beach surface water sampling at Snake Pond (April 2012)
- Recording of daily average treatment system flow rates (January 2012 through December 2012)
- Semiannual sampling of FS-12 treatment plant influent for perchlorate and explosives by the Impact Area Groundwater Study Program (June 2012 and December 2012)
- Periodic sampling of extraction well 90EW0017 in support of a cyclic pumping optimization evaluation

- Installation of a new monitoring well, 90MW0209A, to replace an existing damaged monitoring well (90DP0008).

The groundwater and surface water locations sampled for the FS-12 SPEIM program in 2012 are presented in [Figure 2](#). Well construction and surface water sample location information is included in [Table 1](#). The current approved FS-12 SPEIM network is presented in the *Comprehensive Long Term Monitoring Plan*, which is available from AFCEC.

Groundwater and surface water analytical results are presented in [Table 2](#). A map showing the distribution of EDB detections in groundwater is included as [Figure 3](#). A comparison of compounds detected in groundwater and treatment plant samples to applicable standards is included in [Attachment A](#).

A small-diameter groundwater monitoring well, 90MW0209A, was installed at FS-12 using direct push technology. 90MW0209A was installed adjacent to an existing monitoring well 90DP0008, which was abandoned in place subsequent to the installation of 90MW0209A. The existing monitoring well, 90DP0008, was obstructed and could no longer be sampled. The screen-setting for 90MW0209A was based upon a review of EDB data obtained from a groundwater vertical profile boring advanced at this location in November 2011 (90DP1008). The location of 90MW0209A is shown on [Figure 2](#). Well construction information for this newly installed monitoring well is included in [Table 1](#) and a well construction diagram is included in [Attachment B](#).

#### **Data Summary Report:**

The data summary report for the analytical data reported in this SLR is included in [Attachment C](#).

#### **Presentations:**

Presentations for the FS-12 plume are listed in [Table 3](#).

#### **Project Note Submittals:**

Project notes related to activities conducted for the FS-12 plume under the SPEIM program in 2012 are included in [Attachment D](#).

#### **Report Submittals:**

- *FS-12 2011 Summary Letter Report* submitted in March 2012 (AFCEE 2012b).
- *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum* submitted in August 2012 (AFCEE 2012a).

### **Major Events and Optimizations:**

A cyclic pumping evaluation began at FS-12 extraction well 90EW0017 in February 2011 and continued through December 2012. This extraction well was initially turned off in July 2008 as part of an ETR system optimization (AFCEE 2008). However, a review of monitoring data collected at 90EW0017 and other nearby locations indicated that elevated EDB concentrations remained in groundwater near this extraction well. Operation of 90EW0017 on a cyclic basis is being tested in an effort to capture this area of higher EDB concentrations rather than waiting for the contamination to migrate downgradient to the next operating extraction well (90EW0019). Sustained influent EDB concentrations could not be achieved at 90EW0017 using various operating/rest cycles and flow rates, indicating that this area of EDB contamination had either been remediated by intermittent operation of the extraction well or was very limited in extent. Therefore, a longer rest period of six months, followed by influent sampling immediately upon startup up was selected to determine whether rebound of EDB concentrations in extraction well influent would occur. Elevated EDB concentrations were observed after startup of this well. Cyclic operation of this extraction well will continue and will be incorporated into future operational scenarios selected for the ETR system at FS-12.

A field-scale pilot test site, which will be used to evaluate enhanced in-situ bioremediation of EDB has been established at FS-12. In June 2011, an injection well and several downgradient monitoring wells were installed at the pilot test site (AFCEE 2012b). In the fall of 2012 a self-contained treatment system that will deliver ethane-gas amended water to the aquifer was mobilized to the pilot test site. In October 2012, field testing of this system began with the injection of unamended water into the injection well. In December 2012 a tracer test was initiated to quantify travel times and dispersion of water between the injection well and downgradient monitoring wells at the pilot test site. This pilot test is scheduled to continue into 2013 and an update will be included in the *FS-12 2013 Summary Letter Report*.

### **FS-12 REMEDIAL STATUS UPDATE**

Analytical results for samples collected at the FS-12 treatment plant are presented in [Table 4](#). Average weekly flow rates for the FS-12 ETR system are presented in [Table 5](#). Treatment system operational downtimes or deviations (for events lasting two hours or longer) in 2012 are summarized in [Table 6](#). Mass removal calculations through December 2012 are presented in [Table 7](#).

The plume shell for the FS-12 EDB plume was updated in 2011 and is based on monitoring data collected through December 2010 (AFCEE 2011a). The 2011 plume shell is estimated to contain approximately 156 million gallons of groundwater contaminated with EDB at concentrations above the MMCL; and approximately 1.29 lbs of dissolved-phase EDB at concentrations above the MMCL (AFCEE 2011a).

The FS-12 ETR system removed approximately 0.37 lbs of EDB between January 2012 and December 2012. During this period, approximately 184 million gallons of groundwater were treated at the FS-12 treatment plant. Since startup in 1997, the system

has removed approximately 136.1 lbs of EDB through the treatment of approximately 4.6 billion gallons of groundwater. A total of 56.91 pounds of benzene has been removed by the FS-12 ETR system between 1997 and 1999. Benzene has not been detected in plant influent since November 1999.

The operation of the FS-12 remedial system used approximately 907 megawatt hours of electricity during 2012. Power plant air emissions associated with this power generation for 2012 and since system startup in September 1997 are presented in [Table 8](#). Green energy purchases and power production from AFCEC's wind turbines are incorporated into these air emission data.

The FS-12 ETR system is currently operating under the 2010 Scenario 01 pumping configuration. The latest model transport simulations, which were completed using the 2004 plume shell (and using pumping configuration 2005 Scenario 02), indicate that ETR system operation is required through the last simulation year of 2048 in order to contain the EDB plume (AFCEE 2005). Contaminant transport modeling using the 2011 EDB plume shell will be performed in 2013. These simulations will be used to update the estimates of remedial system operation duration and the time frame to reach aquifer restoration (i.e., when EDB concentrations reach the MMCL). Also, through the SPEIM program, the Conceptual Site Model is routinely updated and the remedial system operation is continuously evaluated and optimized to reduce cleanup times, therefore, the timeframes presented in the preceding section will most likely be decreased in future scenarios.

### **FS-12 SPEIM ACTIVITIES PLANNED FOR 2013**

Activities currently planned for the FS-12 SPEIM program for 2013 include the following:

- Biennial (September 2013) and semiannual (March 2013) groundwater sampling.
- ETR system optimization evaluation using 2011 EDB plume shell (Spring 2013).
- Synoptic water level measurements (as needed).
- Monthly treatment plant sampling (January 2013 through December 2013).
- Recording of daily average treatment system flow rates (January 2013 through December 2013).
- Semiannual sampling of FS-12 treatment plant influent for perchlorate and explosives by the Impact Area Groundwater Study Program.
- FS-12 SPEIM data presentations (as needed).
- Update and submit the *FS-12 Groundwater Plume Conceptual Site Model* deliverable.
- Recreational beach area surface water sampling (May 2013).
- LUC Program private well verification surveys and sampling (as needed).
- Continued evaluation of in-situ bioremediation pilot test.

If you have any questions or comments, please contact Rose Forbes at (508)-968-4670, extension 5613.

Sincerely,

CH2M HILL



Nigel Tindall, P.G.  
Project Manager

Attachments:

<a href="#"><u>Figure 1</u></a>	FS-12 Groundwater Plume and Treatment System
<a href="#"><u>Figure 2</u></a>	FS-12 Groundwater and Surface Water Monitoring Locations
<a href="#"><u>Figure 3</u></a>	FS-12 2012 EDB Detections in Groundwater
<a href="#"><u>Table 1</u></a>	FS-12 Well Construction and Surface Water Sampling Location Information
<a href="#"><u>Table 2</u></a>	FS-12 Groundwater and Surface Water Monitoring Results
<a href="#"><u>Table 3</u></a>	FS-12 Meeting Presentations
<a href="#"><u>Table 4</u></a>	FS-12 Treatment Plant Sampling Results
<a href="#"><u>Table 5</u></a>	FS-12 Treatment System Flow Rates
<a href="#"><u>Table 6</u></a>	FS-12 Treatment System Downtime Summary
<a href="#"><u>Table 7</u></a>	FS-12 Treatment System Mass Removal Summary
<a href="#"><u>Table 8</u></a>	FS-12 Remedial System Electrical Consumption and Associated Air Emissions
<a href="#"><u>Attachment A</u></a>	Comparison of Detected Concentrations in FS-12 Groundwater and Treatment Plant Samples to Applicable Groundwater Standards
<a href="#"><u>Attachment B</u></a>	Well Construction Diagram – 90MW0209A
<a href="#"><u>Attachment C</u></a>	FS-12 2012 SLR Data Summary Report
<a href="#"><u>Attachment D</u></a>	FS-12 Project Notes

\* c: Rose Forbes, AFCEC/MMR  
Dr. Mike Ciaranca, E&RC  
Leonard Pinaud, MassDEP  
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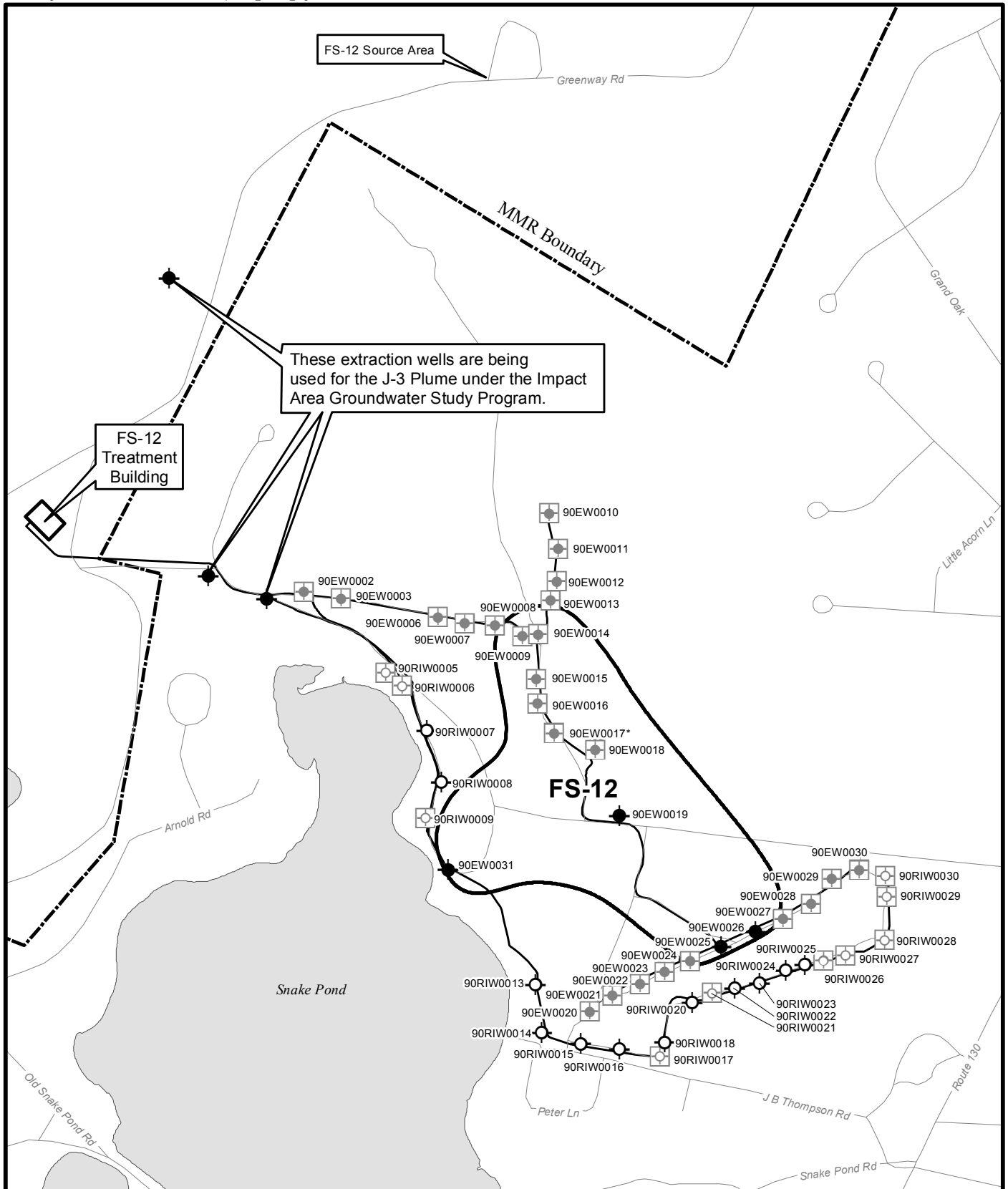
\* Delivery via email.

## REFERENCES

- AFCEE (Air Force Center for Engineering and the Environment). 2012a (August). *Final 2011 MMR Vapor Intrusion Evaluation Technical Memorandum*. 420005-PROGRAM-MULTIPLE-TECHMEM-002. Prepared by CH2M HILL for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2012b (March). *Fuel Spill-12 2011 Summary Letter Report*. 420005-SPEIM-FS12-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2011a (December). *Fuel Spill-12 2011 EDB Plume Shell Update*. 420005-SPEIM-FS12-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

- \_\_\_\_\_. 2011b (September). *Final Explanation of Significant Differences for the Installation Restoration Program Groundwater Plumes at the Massachusetts Military Reservation*. 404929-SPEIM-MULTIPLE-RPT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2010 (September). *Fuel Spill-12 2010 Extraction, Treatment and Reinjection System Optimization*. 389849-SPEIM-FS12-PRJNOT-003. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2008 (July) *Fuel Spill-12 2008 Extraction, Treatment, and Reinjection System Optimization Project Note*. 371335-SPEIM-FS12-PRJNOT-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2006 (September). *Final Record of Decision for Fuel Spill-12 Groundwater*. A3P-J23-35Z04802-M26-0010. Prepared by Jacobs Engineering Group Inc. for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.
- \_\_\_\_\_. 2005 (July). *Final Fuel Spill-12 2005 Optimization Technical Memorandum*. 324146-SPEIM-FS12-TECHMEM-002. Prepared by CH2MHILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.

## FIGURES



### Legend

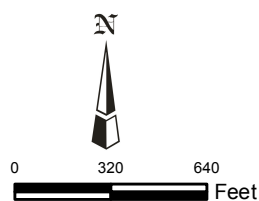
- ◆ Extraction Well (On)
- ◼ Extraction Well (Off)
- ⊕ ReInjection Well (On)
- ◻ ReInjection Well (Off)

- Plume Boundary
- - - MMR Boundary
- Pipeline
- ◻ Treatment Plant

NOTE: Well configuration represents 2010 Scenario 01 Pumping Configuration.

\* Well operated intermittently in 2012 as part of a cyclic pumping evaluation.

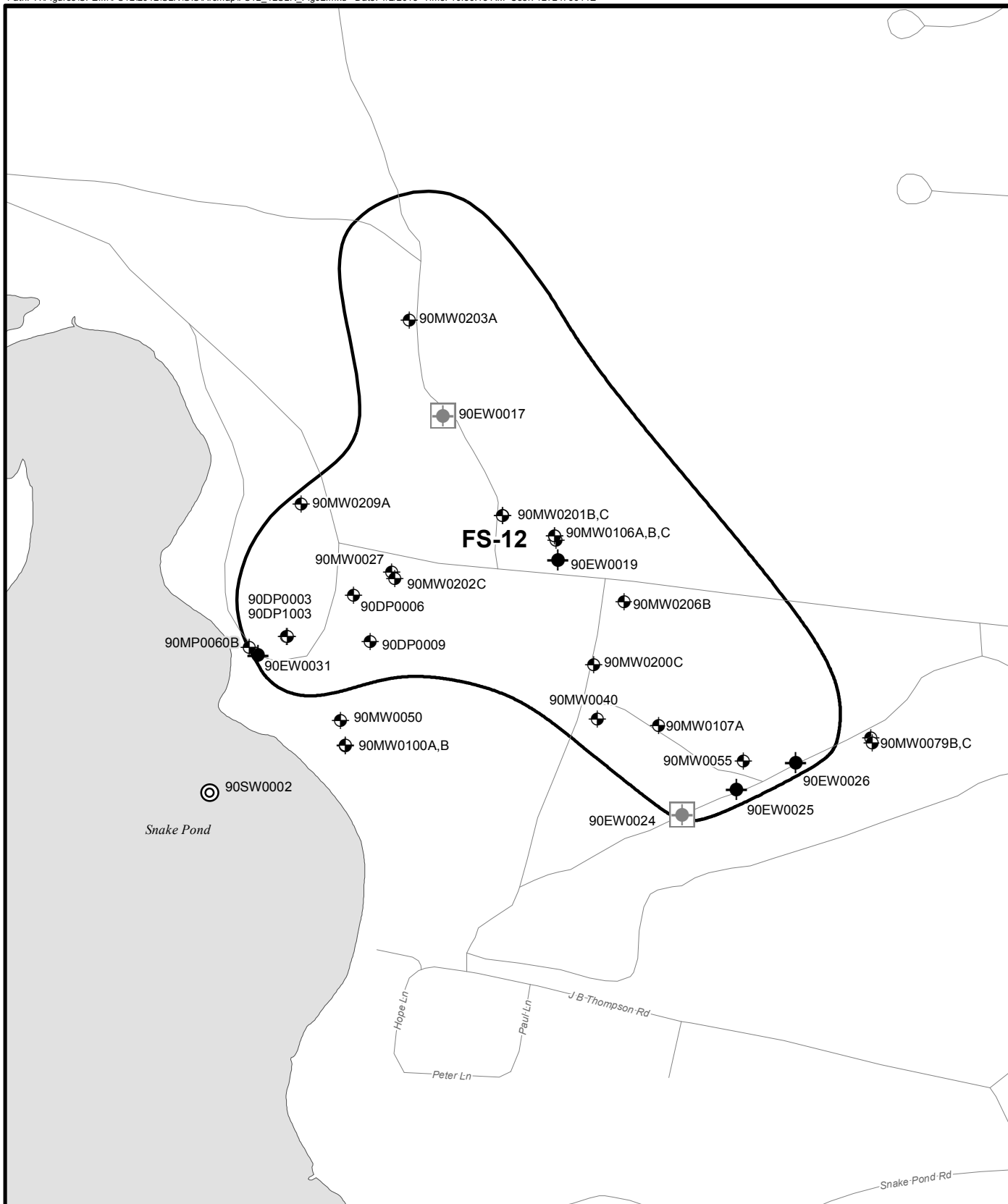
Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011



**FIGURE 1**

### FS-12 GROUNDWATER PLUME AND TREATMENT SYSTEM

AFCEC - Massachusetts Military Reservation  
FS-12 2012 Summary Letter Report



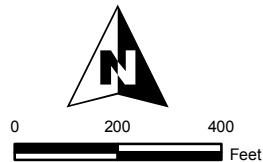
### Legend

- Plume Boundary
- Bog/Wetland
- Monitoring Well

- Extraction Well (On)
- Extraction Well (Off)
- Surface Water Sampling Location

\*Well operated intermittently in 2012 as part of a cyclic pumping evaluation.

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

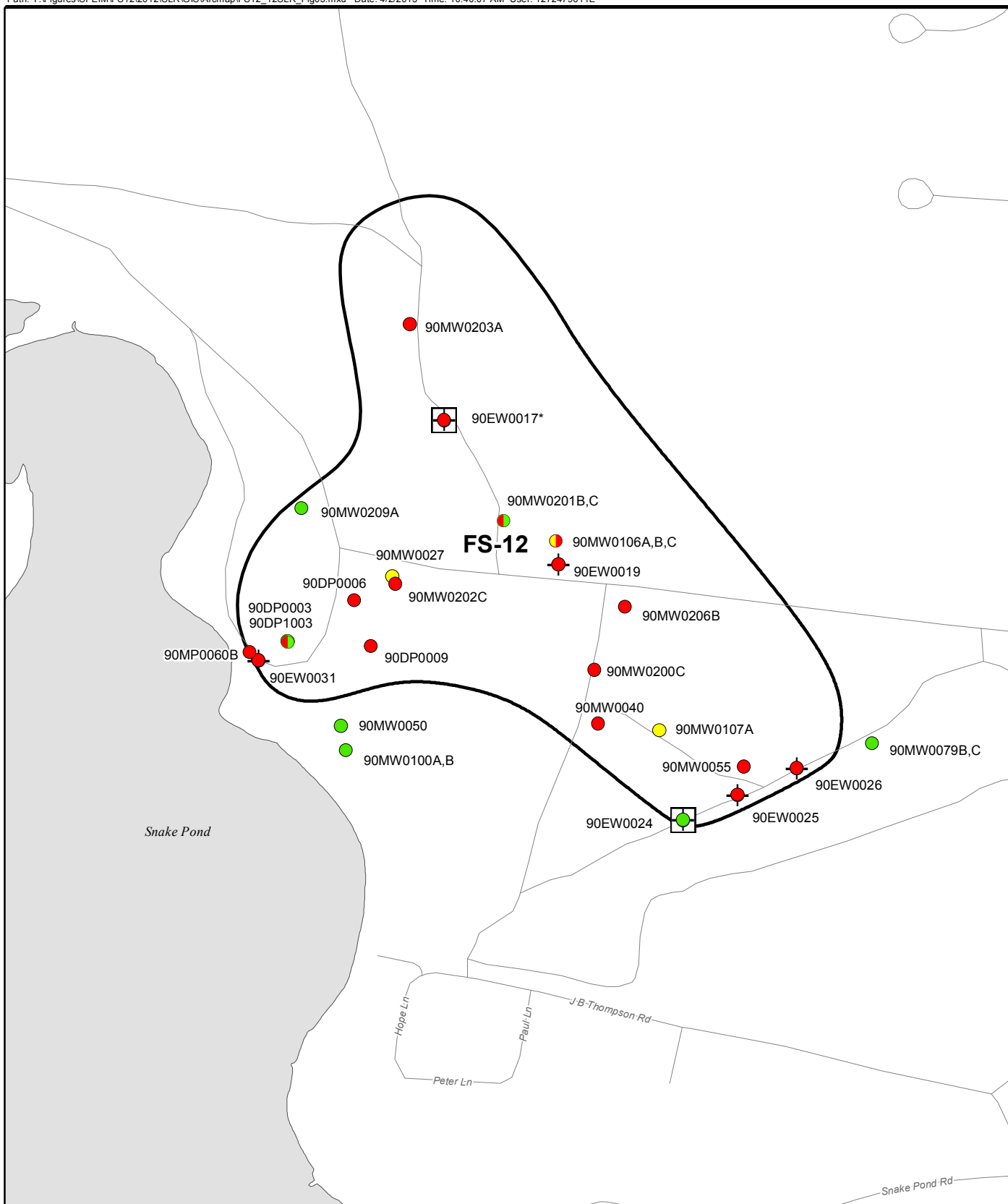


### FIGURE 2

## FS-12 GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS

AFCEC - Massachusetts Military Reservation  
FS-12 2012 Summary Letter Report

**CH2MHILL**



### Legend

- Plume Boundary
- Bog/Wetland
- +

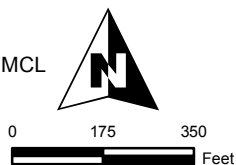
 Extraction Well (On)
- Extraction Well (Off)

\*Well operated intermittently in 2012 as part of a cyclic pumping evaluation

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

### EDB Detections in Groundwater:

- No Detection
- Detection Below or at MMCL
- Detection Above MMCL



### FIGURE 3

### FS-12 2012 EDB DETECTIONS IN GROUNDWATER

AFCEC - Massachusetts Military Reservation  
FS-12 2012 Summary Letter Report

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## **TABLES**

**Table 1**  
**FS-12 Well Construction and Surface Water Sampling Location Information**  
**FS-12 2012 Summary Letter Report**

Location	Northing Coordinate on Surface (ft)	Easting Coordinate on Surface (ft)	Surface Elevation (ft msl)	Measuring Point Elevation (ft msl)	Total Well Depth (ft bgs)	Top Screen Elevation (ft msl)	Bottom Screen Elevation (ft msl)	Screen Length (ft)
90DP0003	251205	868200	103	102.60	216.0	-103.11	-113.11	10
90DP0006	251313	868379	125	124.64	163.5	-27.56	-37.56	10
90DP0009	251190	868423	122	121.41	160.0	-28.48	-38.48	10
90DP1003	251203	868202	103	102.58	161.7	-47.74	-57.74	10
90EW0017*	251793	868618	151	143.34	210.8	-34.77	-54.77	20
90EW0019**	251409	868923	145	137.23	212.0	-43.77	-62.07	18
90EW0024	250729	869255	142	134.75	194.8	12.67	-47.33	60
90EW0025**	250795	869400	148	140.17	208.3	-36.28	-55.40	19
90EW0026**	250866	869558	150	142.23	210.5	-34.37	-55.58	21
90EW0031**	251154	868124	84	77.24	116.6	-14.76	-30.40	16
90MP0060B	251175	868100	83	83.19	153.5	-67.75	-70.25	3
90MW0027	251376	868480	137	136.39	167.9	-26.61	-31.11	5
90MW0040	250985	869029	148	147.39	192.6	-39.94	-44.85	5
90MW0050	250979	868344	83	82.67	90.7	-2.70	-7.57	5
90MW0055	250870	869418	151	150.70	225.0	-68.15	-73.15	5
90MW0079B	250932	869759	151	150.95	191.0	-34.79	-39.79	5
90MW0079C	250920	869762	151	150.98	225.0	-68.80	-73.80	5
90MW0100A	250913	868357	81	80.53	160.0	-73.95	-78.77	5
90MW0100B	250913	868357	81	80.52	104.9	-18.86	-23.68	5
90MW0106A	251472	868916	143	142.08	227.6	-79.95	-84.74	5
90MW0106B	251461	868918	143	142.86	215.0	-66.63	-71.42	5
90MW0106C	251472	868916	143	142.15	194.8	-47.14	-52.19	5
90MW0107A	250966	869192	151	150.89	209.6	-53.28	-58.11	5
90MW0200C	251127	869019	149	148.94	190.1	-35.86	-40.76	5
90MW0201B	251526	868776	147	147.03	205.6	-52.91	-57.53	5
90MW0201C	251526	868776	147	146.78	185.0	-32.60	-37.53	5
90MW0202C	251357	868488	136	135.68	145.1	-4.08	-9.01	5
90MW0203A	252050	868532	153	152.50	204.5	-46.70	-51.34	5
90MW0206B	251295	869101	138	137.48	194.5	-51.93	-56.55	5
90MW0209A	251558	868239	113	112.28	165.6	-47.77	-52.77	5
90SW0001	249001	867841	66	N/A	N/A	N/A	N/A	N/A
90SW0002	250785	867996	66	N/A	N/A	N/A	N/A	N/A

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse

Notes:

\*Extraction well screen shortened to 20 feet by installation of packers in December 2006 as part of the wellfield optimization (2006 Scenario 01).

\*\* Extraction well screens shortened from 60 feet to current screen length by installation of packers in 2005 as part of the wellfield optimization (2005 Scenario 02).

Key:

bgs = below ground surface

msl = mean sea level

FS-12 = Fuel Spill-12

N/A = not applicable

ft = feet

**Table 2**  
**FS-12 Groundwater and Surface Water Monitoring Results**  
**FS-12 2012 Summary Letter Report**

Location	Date	EDB (µg/L) MMCL = 0.02	Field Parameters					
			Temp (°C)	pH (std)	DO (mg/L)	SpC (µS/cm)	ORP (mV)	Turbidity (NTU)
90DP0003	9/12/2012	ND	--	--	--	--	--	--
90DP0006	9/25/2012	0.109	--	--	--	--	--	--
90DP0009	9/12/2012	0.182	15.68	7.03	4.06	63	-243.9	27.3
90DP1003	9/13/2012	0.208	13.47	6.62	3.7	64	-293.2	2.2
90EW0019	4/20/2012	0.422	11.46	6.02	9.56	68	129.9	1
90EW0019	9/14/2012	0.334	12.72	5.92	10.76	63	160.9	3
90EW0024	9/7/2012	ND	14.38	6.24	4.48	63	85.3	76.1
90EW0025	4/20/2012	0.092	11.63	6.22	7.63	72	114.2	1
90EW0025	9/14/2012	0.092	12.22	5.98	10.03	66	159.2	3.5
90EW0026	4/20/2012	0.384	11.77	6.13	8.92	68	124.1	1
90EW0026	9/14/2012	0.337	12.14	6.02	10.9	64	166.7	0
90EW0031	4/20/2012	0.056	13.12	6.5	9.39	79	139.2	1
90EW0031	9/14/2012	0.043	12.74	6.06	11.22	68	176.2	0.8
90MP0060B	9/13/2012	0.09	11.77	6.81	7.56	61	179.7	3
90MW0027	9/10/2012	BRL	--	--	--	--	--	--
90MW0040	9/14/2012	0.636	13.92	6.06	10	54	226.6	0.6
90MW0050	9/10/2012	ND	--	--	--	--	--	--
90MW0055	9/7/2012	27.3	14.05	6.44	0.8	64	33.1	2.1
90MW0079B	9/10/2012	ND	--	--	--	--	--	--
90MW0079C	9/10/2012	ND	--	--	--	--	--	--
90MW0100A	9/10/2012	ND	--	--	--	--	--	--
90MW0100B	9/10/2012	ND	--	--	--	--	--	--
90MW0106A	9/24/2012	0.019	14.48	6.04	8.42	76	224.5	1.1
90MW0106B	9/24/2012	1.02	14.32	6.49	9.21	68	218.3	1.6
90MW0106C	9/24/2012	0.098 J	11.69	5.97	8.01	60	250.2	12.2
90MW0107A	9/10/2012	0.02	--	--	--	--	--	--
90MW0200C	9/10/2012	0.087	--	--	--	--	--	--
90MW0201B	9/10/2012	1.19	--	--	--	--	--	--
90MW0201C	9/10/2012	ND	--	--	--	--	--	--
90MW0202C	9/10/2012	0.071	--	--	--	--	--	--
90MW0203A	9/10/2012	0.057	--	--	--	--	--	--
90MW0206B	9/25/2012	22	--	--	--	--	--	--
90MW0209A	9/13/2012	ND	15.2	6.7	5.42	67	69.5	13.5
<b>Cyclic Pumping Results</b>								
90EW0017	1/9/2012	0.223	9.91	5.83	3.47	86	103.1	3.5
90EW0017	1/11/2012	0.109	9.84	5.65	5.27	84	31.4	0.2
90EW0017	1/17/2012	0.084	10.1	5.44	5.9	107	195.7	0.8
90EW0017	1/23/2012	0.092	9.38	5.59	6.44	119	179.8	19
90EW0017	2/6/2012	0.088	9.16	5.92	6.7	66	140.6	1.1
90EW0017	9/4/2012	0.535	NM	NM	NM	NM	NM	NM
90EW0017	10/3/2012	0.117	11.42	6.75	7.56	65	150.7	0.3
90EW0017	11/6/2012	0.626	9.78	6.62	5.88	68	102.4	1.5
90EW0017	12/5/2012	0.138	10.4	6.24	6.92	68	192.1	4.3

**Table 2**  
**FS-12 Groundwater and Surface Water Monitoring Results**  
**FS-12 2012 Summary Letter Report**

Location	Date	EDB (µg/L) AWQC = 9,600*	Field Parameters					
			Temp (°C)	pH (std)	DO (mg/L)	SpC (µS/cm)	ORP (mV)	Turbidity (NTU)
Surface Water Results*								
90SW0001	4/11/2012	ND	12.86	7.08	11.08	96	180.5	0
90SW0002	4/11/2012	ND	11.98	7.07	10.98	96	173.2	0

Data Source: AFCEC, January 2013, MMR-AFCEC Data Warehouse

Notes:

MMCL from Massachusetts Department of Environmental Protection (MassDEP) web page, <http://www.mass.gov/dep/water/dwstand.pdf>.

-- : Sample collected through the use of passive diffusion bag sampler; field parameter collection not performed.

**Bold** values indicate MMCL exceedances.

\* Surface water result compared to the Massachusetts Department of Environmental Protection (MassDEP) Ambient Water Quality Criteria (AWQC) Standard of 9,600 µg/L for EDB, AWQC table at 310 CMR 40.1516(1) from MassDEP web page <http://www.mass.gov/dep/service/regulations/310cmr40.pdf>.

Key:

AWQC = Ambient Water Quality Criteria

BRL = below reporting limit

°C = degrees Celsius

DO = dissolved oxygen

EDB = ethylene dibromide

FS-12 = Fuel Spill-12

J = estimated value

MMCL = Massachusetts Maximum Contaminant Level

mg/L = milligrams per liter

mV = millivolts

ND = not detected

NM = not measured, field parameters not collected.

NTU = nephelometric turbidity units

ORP = oxidation-reduction potential

SpC = specific conductance

Temp = temperature

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

**Table 3**  
**FS-12 Meeting Presentations**  
**FS-12 2012 Summary Letter Report**

**Technical Update Meetings**

26 April 2012	FS-12 2011 Annual SPEIM Data Presentation
20 June 2012	FS-12 2011 Annual SPEIM Data Presentation Follow Up

**MMR Cleanup Team (MMRCT)**

No presentations

**SMB Meetings**

No presentations

**Conferences**

No presentations

**Table 4**  
**FS-12 Treatment Plant Sampling Results**  
**FS-12 2012 Summary Letter Report**

Month of Event	Sample Date	Location Identification	Sample Location	Laboratory Analyses		Water Quality Parameters					
				EDB (µg/L) MMCL = 0.02	Perchlorate** (µg/L) MMCL=2	Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH (std)	ORP (mV)	Turbidity (NTU)
February	30-Jan-12	90PLT01001	Influent	0.281	NS	--	--	--	--	--	--
		90PLT01023	Post-101A (lag)	0.012	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
Carbon was replaced in 101B (lead vessel) on 24 February 2012. Following carbon replacement, CF101A was aligned as lead vessel and CF101B as the lag vessel.											
March	29-Feb-12	90PLT01001	Influent	0.305	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
April	27-Mar-12	90PLT01001	Influent	0.299	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
May	26-Apr-12	90PLT01001	Influent	0.263	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
June	29-May-12	90PLT01001	Influent	0.213	NS	10.62	61	9.02	5.58	199.1	0.0
		90PLT01024	Post-101B (lag)	ND	NS	10.84	60	7.09	5.68	176.2	0.0
		90PLT01041	Post-103A (lag)	ND	NS	10.84	60	8.22	5.75	196.2	0.0
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	10.86	59	7.23	5.78	197.0	0.0
		90PLT01053	Effluent	ND	NS	10.77	59	10.06	5.67	201.4	0.4
July	6/26/2012**	90PLT01001	Influent	0.228	NS	--	--	--	--	--	--
		90PLT01006**	Influent mixing tank	NS	0.046	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
August	18-Jul-12	90PLT01001	Influent	0.248	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	BRL	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--

**Table 4**  
**FS-12 Treatment Plant Sampling Results**  
**FS-12 2012 Summary Letter Report**

Month of Event	Sample Date	Location Identification	Sample Location	Laboratory Analyses		Water Quality Parameters					
				EDB (µg/L) MMCL = 0.02	Perchlorate** (µg/L) MMCL=2	Temp (°C)	SpC (µS/cm)	DO (mg/L)	pH (std)	ORP (mV)	Turbidity (NTU)
September	28-Aug-12	90PLT01001	Influent	0.218	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01041	Post-103A (lag)	0.012 J	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
Carbon was replaced in 103B (lead vessel) on 24 September 2012. Following carbon replacement, CF103A was aligned as lead vessel and CF103B as the lag vessel.											
October	27-Sep-12	90PLT01001	Influent	0.253	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01042	Post-103B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
November	25-Oct-12	90PLT01001	Influent	0.203	NS	--	--	--	--	--	--
		90PLT01024	Post-101B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01042	Post-103B (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--
December	28-Nov-12	90PLT01001	Influent	0.194 J	NS	10.51	58	9.74	6.10	254.5	0.2
		90PLT01024	Post-101B (lag)	ND	NS	10.62	57	9.21	6.13	258.2	0.0
		90PLT01042	Post-103B (lag)	ND	NS	10.60	57	9.33	6.17	246.2	0.0
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	10.61	57	8.73	6.18	249.0	0.5
		90PLT01053	Effluent	ND	NS	10.52	58	10.97	6.20	211.7	0.1
January	26-Dec-12	90PLT01001	Influent	0.155	NS	--	--	--	--	--	--
		90PLT01006	Influent mixing tank	NS	ND	--	--	--	--	--	--
		90PLT01024	Post-101A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01042	Post-103A (lag)	ND	NS	--	--	--	--	--	--
		90PLT01033	Post-102B (Lead Vessel)	ND	NS	--	--	--	--	--	--
		90PLT01053	Effluent	ND	NS	--	--	--	--	--	--

Data Source: AFCEC, February 2013, MMR-AFCEC Data Warehouse.

**Notes:**

EDB samples analyzed by EPA Method 504.1; Perchlorate analyzed by EPA Method SW 6850.

**Bold** indicates value exceeds MMCL.

Water quality parameters (pH, temperature, DO, SpC, turbidity, and ORP) are recorded semiannually at influent, post-GAC at each active GAC vessel, and plant effluent sampling locations. The measurements are taken using a flow-through cell and the Yellow Springs Instrument (YSI).

\*\* The effluent to the FS-12 influent holding tank (90PLT01006) is sampled semi-annually by the Army for perchlorate analysis as part of their J-3 Plume treatment system Operations and Maintenance Plan.

--: Water quality parameters were not collected.

**Key:**

BRL = below reporting limit

°C = degrees Celsius

DO = dissolved oxygen

EDB = ethylene dibromide

FS-12 = Fuel Spill-12

J = estimated value

mg/L = milligrams per liter

MMCL = Massachusetts Maximum Contaminant Level

mV = millivolts

ND = not detected

NS = not sampled

NTU = nephelometric turbidity units

ORP = oxidation-reduction potential

std = standard units

SpC = specific conductance

Temp = temperature

µg/L = micrograms per liter

µS/cm = microsiemens per centimeter

Table 5  
FS-12 Treatment System Flow Rates  
FS-12 2012 Summary Letter Report

Week Ending	Extraction Wells					Total	Reinjection Wells											Total *	
	90EW0017***	90EW00019	90EW00025	90EW00026	90EW00031		90RIW00007	90RIW00008	90RIW00014	90RIW00015	90RIW00016	90RIW00017**	90RIW00018	90RIW00020	90RIW00022	90RIW00023	90RIW00024		90RIW00025
7-Jan-12	0	111	49	70	120	350	17	40	40	40	41	40	44	41	41	48	41	41	473
14-Jan-12	16	110	49	70	120	365	17	42	42	42	42	42	43	42	42	48	42	42	487
21-Jan-12	20	110	50	70	120	369	17	42	42	42	43	42	43	43	43	48	43	43	490
28-Jan-12	20	109	51	70	120	370	17	42	42	42	43	42	42	43	43	48	43	43	491
4-Feb-12	20	109	51	70	120	370	17	42	42	42	43	42	42	43	43	48	43	43	491
11-Feb-12	4	110	51	70	120	355	17	41	41	41	41	41	42	41	41	48	41	41	475
18-Feb-12	0	110	51	70	120	350	17	40	40	40	40	40	42	40	40	49	40	40	470
25-Feb-12	0	110	51	70	120	350	17	40	40	40	40	40	42	40	40	49	40	40	470
3-Mar-12	0	110	51	70	120	350	17	40	40	40	40	40	42	40	40	49	40	40	469
10-Mar-12	0	110	50	70	120	350	16	40	40	40	40	40	42	40	40	49	40	40	468
17-Mar-12	0	110	50	70	120	350	17	40	40	40	40	40	42	40	40	49	40	40	471
24-Mar-12	0	110	50	70	120	350	17	40	40	40	41	40	42	41	41	49	41	41	472
31-Mar-12	0	109	50	70	120	349	17	40	40	40	40	40	42	40	40	49	40	40	469
7-Apr-12	0	109	50	70	120	349	17	40	40	40	41	40	42	41	41	49	41	41	471
14-Apr-12	0	109	50	70	119	348	17	40	40	40	40	40	42	40	40	49	40	40	467
21-Apr-12	0	109	50	70	119	348	17	40	40	40	40	40	42	40	40	49	40	40	468
28-Apr-12	0	109	49	70	120	348	14	33	33	33	34	33	43	34	34	51	34	34	409
5-May-12	0	109	49	70	120	348	12	30	30	30	30	30	43	30	45	36	30	30	378
12-May-12	0	109	50	70	120	348	14	35	35	35	35	35	42	35	50	35	35	35	422
19-May-12	0	109	49	70	119	347	16	39	39	39	39	39	41	39	49	39	39	39	460
26-May-12	0	109	49	70	116	344	17	40	39	39	39	39	41	39	49	39	39	39	462
2-Jun-12	0	108	50	70	119	348	17	40	40	40	40	40	41	40	47	42	40	40	467
9-Jun-12	0	108	50	70	120	348	17	40	40	40	41	40	41	41	41	49	41	41	471
16-Jun-12	0	108	49	70	120	347	17	40	40	40	40	40	41	40	40	49	40	40	470
23-Jun-12	0	108	50	70	119	347	16	39	39	39	40	39	44	40	40	52	40	40	468
30-Jun-12	0	89	45	70	98	302	15	36	36	36	36	36	46	36	36	53	36	36	437
7-Jul-12	0	107	50	70	120	347	16	39	40	40	39	39	42	39	39	49	39	40	462
14-Jul-12	0	97	45	64	111	318	18	38	39	38	39	39	42	39	40	49	40	40	462
21-Jul-12	0	101	47	66	110	325	16	39	38	38	38	38	42	38	38	50	38	38	452
28-Jul-12	0	107	50	70	120	346	15	37	37	38	38	38	44	38	38	51	38	38	450
4-Aug-12	0	107	45	70	120	342	16	38	36	36	36	36	44	37	36	50	36	36	437
11-Aug-12	0	107	50	70	120	347	14	33	32	32	32	32	44	32	32	51	32	32	398
18-Aug-12	0	107	49	70	120	346	16	38	38	38	38	38	43	38	38	49	38	38	450
25-Aug-12	0	106	49	70	120	345	16	38	38	38	38	38	43	38	38	49	38	38	453
1-Sep-12	0	106	49	70	120	346	16	39	38	38	39	38	43	39	39	49	39	39	456
8-Sep-12	26	104	50	70	120	370	17	41	41	41	41	41	42	41	41	49	41	41	480
15-Sep-12	40	104	50	70	120	384	18	42	42	42	42	42	41	42	42	48	42	42	488
22-Sep-12	40	103	50	70	120	383	17	42	42	42	43	42	41	43	43	48	43	43	490
29-Sep-12	40	104	50	70	120	383	18	43	40	40	40	40	41	40	40	49	40	40	472
6-Oct-12	29	103	50	70	103	355	17	39	38	39	39	38	42	40	39	48	38	39	456
13-Oct-12	0	105	50	70	120	344	17	40	39	39	42	40	41	41	40	49	40	40	469
20-Oct-12	0	103	50	70	120	343	16	36	36	37	37	39	41	38	39	49	39	39	446
27-Oct-12	0	104	50	70	120	343	15	35	35	36	35	34	42	35	33	50	33	35	417
3-Nov-12	0	84	42	68	98	292	13	33	43	33	33	26	35	27	41	41	28	28	382
10-Nov-12	26	96	50	55	120	346	13	32	44	32	32	31	40	32	51	44	32	32	415
17-Nov-12	40	95	50	70	120	375	16	39	44	39	39	39	40	39	51	43	39	39	465
24-Nov-12	40	95	50	70	120	375	16	39	43	39	39	39	39	39	50	43	39	39	465
1-Dec-12	40	95	50	70	120	375	17	38	43	38	39	38	39	39	50	43	39	39	464
8-Dec-12	20	96	50	70	120	356	15	36	43	36	37	36	40	37	43	44	37	37	440
15-Dec-12	0	95	48	69	114	325	14	32	43	35	34	35	41	35	51	44	35	35	433
22-Dec-12	0	98	50	70	120	338	13	30	44	30	31	30	42	31	50	45	31	31	407
29-Dec-12	0	96	50	70	120	336	14	33	43	33	34	33	41	34	50	44	34	34	428
Average Flow Rate (gpm)	N/A	105	49	69	118	350	16	38	40	38	39	38	42	38	42	47	38	38	455
Optimized Design Flow Rate (gpm) (2010 Scenario 01)	N/A	120	50	70	120	360	20	47	46	46	46	46	46	46	46	46	46	46	466
Percent of Optimized Design Rate	N/A	87	99	99	98	97	80	82	86	83	84	83	91	84	91	102	84	84	98

Data Source: AFCEC, January 2013, AFCEC-MMR Data Warehouse.

Notes:

Only wells that were operational in 2012 are listed.

All flow rates are in gallons per minute (gpm).

Any downtime due to routine and non-routine operation and maintenance activities is included in the average flow rates.

Due to small-scale inaccuracies of the electronic flow rate meters, removal of relatively small amounts of water at the plant and use of operator log-book data (when electronic flow data is not available) the recorded influent rates may not equal the recorded effluent flow rates.

\* Total flow rate at injection wells includes approximately 106 gpm of treated J-3 Range effluent.

\*\* Due to high water table adjacent to Snake Pond, flow is being diverted from 90RIW0013 to 90RIW0017.

\*\*\* 90EW0017 operated intermittently for a cyclic pumping optimization evaluation in 2012.

Key:

gpm = gallons per minute

N/A = not applicable

**Table 6**  
**FS-12 Treatment System Downtime Summary**  
**FS-12 2012 Summary Letter Report**

Date	Hours Off-Line	Reason
3/30/2012	3.17	Plant tripped off due to a power failure.
6/26/2012	15.75	Power outage during thunderstorm.
6/26/2012	19.83	90EW0031 power during thunderstorm; no communication to MCC-1.
7/12/2012	15.50	Energy curtailment.
7/18/2012	9.38	Power failure during thunderstorms.
7/27/2012	4.50	MCC-1 and 90EW0031 off due to communications issue.
10/29/2012	23.50	Intentionally shut plant down due to hurricane/possible energy curtailment.
10/30/2012	8.25	System tripped due to high effluent tank.
11/3/2012	37.10	90EW00026 off. Well tripped and had to be reset at MCC.
12/10/2012	4.58	Plant tripped off due to a power failure. Blown fuses at Camp Good News
12/13/2012	5.73	90EW0019 off due to a bad starter; replaced starter.

Key:

MCC = motor control center

**Table 7**  
**FS-12 Treatment System Mass Removal Summary**  
**FS-12 2012 Summary Letter Report**

Date	EDB Monthly Removal (lbs)	EDB Cumulative Removal (lbs)	Benzene Cumulative Removal (lbs)
Jan-12	0.04	135.80	56.91
Feb-12	0.04	135.80	56.91
Mar-12	0.04	135.80	56.91
Apr-12	0.03	135.90	56.91
May-12	0.03	135.90	56.91
Jun-12	0.03	135.90	56.91
Jul-12	0.03	136.00	56.91
Aug-12	0.03	136.00	56.91
Sep-12	0.03	136.00	56.91
Oct-12	0.03	136.00	56.91
Nov-12	0.03	136.10	56.91
Dec-12	0.02	136.10	56.91
<b>EDB removed (lbs) by ETR system during reporting period (January 2012 - December 2012)</b>			0.37
<b>Total EDB removed (lbs) since system startup (September 1997 - December 2012)</b>			136.10
<b>Total Benzene removed (lbs) since system startup (September 1997 - December 2012)*</b>			56.91
<b>Total COCs removed (lbs) since system startup (September 1997 - December 2012)</b>			193.01

Data Source: AFCEC, February 2013, MMR-AFCEC Data Warehouse.

\* Treatment plant influent is no longer monitored for benzene. This analyte was last detected in plant influent in November 1999.

Key:

COC = contaminant of concern

EDB = ethylene dibromide

ETR = extraction, treatment, and reinjection

lbs = pounds

**Table 8**  
**FS-12 Remedial System Electrical Consumption and Associated Air Emissions**  
**FS-12 2012 Summary Letter Report**

Volume of Groundwater Treated (million gallons)		1/1/2012 to 12/31/2012	System Startup (9/1997) to 12/31/2012
		<b>184</b>	<b>4,600</b>
Groundwater COC Mass Removal (pounds)		<b>0.37</b>	<b>193</b>
Electrical Usage (MWh)		<b>907</b>	<b>22,063</b>
Estimated Air Emissions <sup>1</sup> (based on electrical usage)	CO <sub>2</sub> (tons)	594	17,913
	NO <sub>x</sub> (lbs)	1,279	28,302
	PM-10 (lbs)	73	1,065
	SO <sub>2</sub> (lbs)	3,410	33,543
	VOCs (lbs)	45	1,308
Estimated Reduction in Air Emissions due to Green Power Purchases <sup>2</sup>	CO <sub>2</sub> (tons)	64	471
	NO <sub>x</sub> (lbs)	138	937
	PM-10 (lbs)	8	49
	SO <sub>2</sub> (lbs)	368	2,169
	VOCs (lbs)	5	35
Estimated Reduction in Air Emissions due to MMR Wind Turbine Operation <sup>3</sup>	CO <sub>2</sub> (tons)	612	991
	NO <sub>x</sub> (lbs)	1,318	2134
	PM-10 (lbs)	75	122
	SO <sub>2</sub> (lbs)	3,514	5690
	VOCs (lbs)	46	75
Estimated Total Air Emissions with consideration of Green Power Purchases and MMR Wind Turbine Operation	CO <sub>2</sub> (tons)	<b>0</b>	<b>16,533</b>
	NO <sub>x</sub> (lbs)	<b>0</b>	<b>25,408</b>
	PM-10 (lbs)	<b>0</b>	<b>903</b>
	SO <sub>2</sub> (lbs)	<b>0</b>	<b>26,156</b>
	VOCs (lbs)	<b>0</b>	<b>1,205</b>

Notes:

1) The estimated air emissions presented in this table are based on the assumption that until 4/30/2009, the power used to operate the MMR remedial systems was provided by the Mirant Canal Station power plant in Sandwich, MA. This power plant primarily produced electricity generated by the combustion of fuel oil and has been off-line since 5/1/2009. Starting on 5/1/2009, air emissions are based on electricity generated by the average mix of power sources in Massachusetts. Air emissions were calculated using MMR utility data from AFCEC's Metrix 4 Utility Accounting Software (<http://www.abraxasenergy.com/metrix4.php>) and emission factors obtained from the following websites:  
<http://www.csgnetwork.com/elecpowerpolcalc.html>  
<http://www.metrixcentral.com/EmissionsCalculator/Emissions%20Factors%202004.pdf>

2) Emissions offset by purchases of electricity from renewable sources beginning 7/1/2008 and ending on 8/1/2012.  
3) Emissions offset by operation of AFCEC-owned wind turbines beginning on 12/2/2009 (Wind I) and 11/8/2011 (Wind II).

Key:

COC = contaminant of concern  
CO<sub>2</sub> = carbon dioxide  
FS-12 = Fuel Spill-12  
lbs = pounds  
MMR = Massachusetts Military Reservation  
MWh = megawatt hours  
NO<sub>x</sub> = nitrogen oxides  
PM-10 = particulate matter with a diameter of 10 micrometers or less  
SO<sub>2</sub> = sulfur dioxide  
VOCs = volatile organic compounds

**ATTACHMENT A**  
**Comparison of Detected Concentrations in FS-12 Groundwater  
and Treatment Plant Samples to Applicable Groundwater  
Standards**

**Attachment A**  
**Comparison of Detected Concentrations in FS-12 Groundwater and Treatment Plant Samples to Applicable Groundwater Standards**  
**FS-12 2012 Summary Letter Report**

Location Identification	Sample Date	Sample Elevation (ft msl)	Matrix	Test	Analyte	Analyte Result	DL	RL	Standard	Type¹	Standard Exceeded?
						All units - µg/L					
90DP0006	9/25/2012	-32.56	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.109	0.005	0.01	0.02	MMCL	Yes
90DP0009	9/12/2012	-33.48	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.182	0.005	0.01	0.02	MMCL	Yes
90DP1003	9/13/2012	-52.74	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.208	0.005	0.01	0.02	MMCL	Yes
90EW0017	1/9/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.223	0.01	0.02	0.02	MMCL	Yes
90EW0017	1/11/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.109	0.005	0.01	0.02	MMCL	Yes
90EW0017	1/17/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.084	0.005	0.01	0.02	MMCL	Yes
90EW0017	1/23/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	0.02	MMCL	Yes
90EW0017	2/6/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.088	0.005	0.01	0.02	MMCL	Yes
90EW0017	9/4/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.535	0.024	0.049	0.02	MMCL	Yes
90EW0017	10/3/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.117	0.005	0.01	0.02	MMCL	Yes
90EW0017	11/6/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.626	0.025	0.049	0.02	MMCL	Yes
90EW0017	12/5/2012	-44.77	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.138	0.005	0.01	0.02	MMCL	Yes
90EW0019	4/20/2012	-52.92	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.422	0.01	0.019	0.02	MMCL	Yes
90EW0019	9/14/2012	-52.92	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.334	0.01	0.02	0.02	MMCL	Yes
90EW0025	4/20/2012	-45.84	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	0.02	MMCL	Yes
90EW0025	9/14/2012	-45.84	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	0.02	MMCL	Yes
90EW0026	4/20/2012	-44.975	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.384	0.01	0.019	0.02	MMCL	Yes
90EW0026	9/14/2012	-44.975	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.337	0.009	0.019	0.02	MMCL	Yes
90EW0031	4/20/2012	-22.58	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.056	0.005	0.01	0.02	MMCL	Yes
90EW0031	9/14/2012	-22.58	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.043	0.005	0.01	0.02	MMCL	Yes
90MP0060B	9/13/2012	-69	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.09	0.005	0.01	0.02	MMCL	Yes
90MW0027	9/10/2012	-28.86	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
90MW0040	9/14/2012	-42.395	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.636	0.024	0.049	0.02	MMCL	Yes
90MW0055	9/7/2012	-70.65	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	27.3	0.969	1.94	0.02	MMCL	Yes
90MW0106A	9/24/2012	-82.345	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.019	0.005	0.01	0.02	MMCL	No
90MW0106B	9/24/2012	-69.025	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	1.02	0.048	0.096	0.02	MMCL	Yes
90MW0106C	9/24/2012	-49.665	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.098 J	0.005	0.01	0.02	MMCL	Yes
90MW0107A	9/10/2012	-55.695	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.02	0.005	0.01	0.02	MMCL	No
90MW0200C	9/10/2012	-38.31	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.087	0.005	0.01	0.02	MMCL	Yes
90MW0201B	9/10/2012	-55.22	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	1.19	0.051	0.102	0.02	MMCL	Yes
90MW0202C	9/10/2012	-6.545	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.071	0.005	0.011	0.02	MMCL	Yes
90MW0203A	9/10/2012	-49.12	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.057	0.005	0.01	0.02	MMCL	Yes
90MW0206B	9/25/2012	-54.24	WG	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	22	1	2	0.02	MMCL	Yes
90PLT01001 (INF)	1/30/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.281	0.01	0.02	0.02	MMCL	Yes
90PLT01001 (INF)	2/29/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.305	0.01	0.02	0.02	MMCL	Yes
90PLT01001 (INF)	3/27/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.299	0.01	0.02	0.02	MMCL	Yes
90PLT01001 (INF)	4/26/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.263	0.01	0.019	0.02	MMCL	Yes
90PLT01001 (INF)	5/29/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.213	0.005	0.01	0.02	MMCL	Yes
90PLT01001 (INF)	6/28/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.228	0.01	0.02	0.02	MMCL	Yes
90PLT01001 (INF)	7/18/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.248	0.01	0.02	0.02	MMCL	Yes
90PLT01001 (INF)	8/28/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.218	0.005	0.01	0.02	MMCL	Yes
90PLT01001 (INF)	9/27/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.253	0.01	0.019	0.02	MMCL	Yes
90PLT01001 (INF)	10/25/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.203	0.005	0.01	0.02	MMCL	Yes
90PLT01001 (INF)	11/28/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.194 J	0.005	0.01	0.02	MMCL	Yes
90PLT01001 (INF)	12/26/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.155	0.005	0.01	0.02	MMCL	Yes
90PLT01006 (MID)	6/21/2012	N/A	WW	SW6850	PERCHLORATE	BRL	0.015	0.2	2	MMCL	No

**Attachment A**  
**Comparison of Detected Concentrations in FS-12 Groundwater and Treatment Plant Samples to Applicable Groundwater Standards**  
**FS-12 2012 Summary Letter Report**

Location Identification	Sample Date	Sample Elevation (ft msl)	Matrix	Test	Analyte	Analyte Result	DL	RL	Standard	Type <sup>1</sup>	Standard Exceeded?
						All units - µg/L					
90PLT01023 (MID)	1/30/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012	0.005	0.01	0.02	MMCL	No
90PLT01041 (MID)	7/18/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	0.02	MMCL	No
90PLT01041 (MID)	8/28/2012	N/A	WW	E504.1	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012 J	0.005	0.01	0.02	MMCL	No

Data Source: AFCEC, February 2013, MMR-AFCEC Data Warehouse

Note:

1. MMCL from Massachusetts Department of Environmental Protection (MassDEP) web page, <http://www.mass.gov/dep/water/dwstand.pdf>.

Key:

BRL = below reporting limit

N/A = not applicable

DL = detection limit

RL = reporting limit

ft msl = feet mean sea level

WG = groundwater sample

INF = treatment plant influent

WW = plant water

MID = treatment plant midpoint sample

µg/L = micrograms per liter

J = estimated value

MMCL = Massachusetts Maximum Contaminant Level

**ATTACHMENT B**  
**Well Construction Diagram**

**90MW0209A**

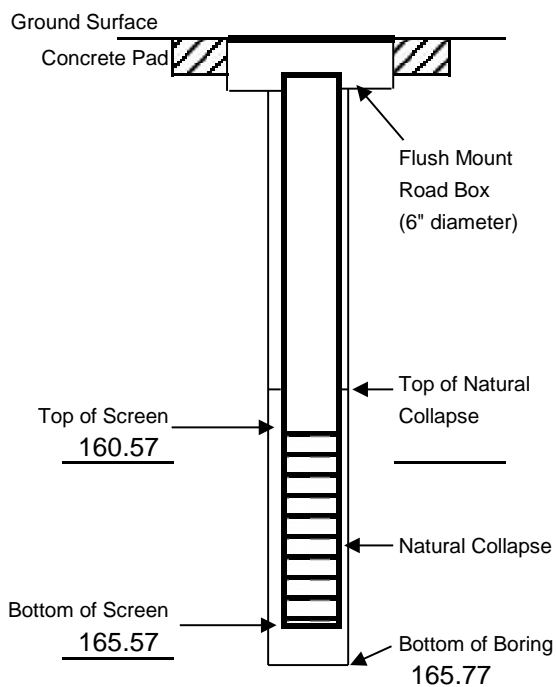


## SMALL DIAMETER DRIVEN WELL INSTALLATION LOG

### PIEZOMETER/WELL INSTALLATION DIAGRAM

Project Name:	SPEIM/LTM	LOC ID:	90MW0209A
Project Number:	420005-SPEIM-FS-12	Total Borehole Depth:	165.77 feet bgs
Date Started:	28-Feb-12	Total Well Depth:	165.57 feet bgs
Date Completed:	5-Mar-12	Construction Materials:	Mild steel
Rig Type:	Geoprobe 6620DT	MP Elevation:	112.28 feet msl
Rig Operator:	Kurt Lyons	Surface Elevation:	112.80 feet msl
Borehole Diameter (in):	1.5	Northing:	251557.75
Well Diameter (in):	0.625 ID	Easting:	868239.26

#### GRAPHICAL REPRESENTATION



#### PIEZOMETER/WELL MATERIAL DESCRIPTIONS

Well Riser: Flush joint; mild steel; threaded; 1.5-inch outer diameter; 5-foot long sections

Well Screen: Flush joint; mild steel; threaded; 0.010-in slot size; 1.5 inch outer diameter; 5-foot long sections; natural collapse.

Bentonite Grout: NA

Flush Mount Box: Environmental Manufacturing, Inc.; steel construction; 6-inch diameter; 10-inch depth.

Well Cap: Torquer Plug; 0.5 inch expandable locking well plug.

#### LEGEND:

LOC ID: Location Identification  
MP: Measuring Point  
in: inches  
ft: feet  
msl: mean sea level  
bgs: below ground surface

#### INSTALLATION NOTES:

FIRST WATER: \_\_\_\_\_

REFUSAL: NA

OTHER: Borehole depths are from ft bgs

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**ATTACHMENT C**

**FS-12 2012 SLR**

**Data Summary Report**

**Attachment C**  
**Data Summary Report**  
**Fuel Spill-12 2012 Summary Letter Report**

## INTRODUCTION

The objective of this data summary report (DSR) is to assess the data quality of analytical results for samples collected for the Fuel Spill-12 System Performance and Ecological Impact Monitoring (SPEIM) Program at the Massachusetts Military Reservation (MMR) as presented in the *Fuel Spill-12 2012 Summary Letter Report*. This report is intended as a general data quality assessment designed to summarize data issues.

## ANALYTICAL DATA

This DSR covers 42 groundwater samples with two field duplicate samples, two surface water samples, and 60 wastewater samples. Field duplicates are not required for treatment facility plant samples. These samples were reported under 30 sample delivery groups. Samples were collected between 09 January 2012 and 26 December 2012. The analyses were performed by Analytics Environmental Laboratory LLC (ANAP) in Portsmouth, New Hampshire. Samples were collected and either shipped by overnight carrier or delivered by courier to ANAP for analysis. Samples were analyzed for the analyte/method provided in Table C-1.

**Table C-1**  
**Analytical Parameter**

Parameter	Method	Laboratory
Ethylene Dibromide (EDB)	E504.1	ANAP

E = Environmental Protection Agency (EPA) Method

The data were assessed using the MMR SPEIM Quality Assurance Project Plan (QAPP)<sup>1</sup>. The assessment included a review of the following:

- Chain-of-Custody documentation

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<sup>1</sup> AFCEE. 2012 (July). *Quality Assurance Project Plan for the MMR SPEIM/LTM/O&M Program*. 420005-Program-Multiple-QAPP-001. Prepared by CH2M HILL for AFCEE/MMR Installation Restoration Program, Otis Air National Guard Base, MA.

- Holding time compliance
- Required quality control (QC) samples at the specified frequencies
- Method blanks
- Laboratory control spiking samples
- Surrogate spike recoveries
- Initial and continuing calibration information and other method-specific criteria as defined by the SPEIM QAPP

Field samples were reviewed to ascertain field compliance and data quality issues. This included a review of trip blanks, equipment blanks, and field duplicates.

Data were carried through data validation as described in the SPEIM QAPP and data flags were assigned according to the SPEIM QAPP. These flags, and the reason for each flag, were entered into the electronic database and can be found in Table C-2 (located at the end of this attachment). Multiple flags are routinely applied to specific sample method/matrix/analyte combinations, but there is only one final flag. A final flag is applied to the data, and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

The data flags are listed in the SPEIM QAPP and are defined as follows:

- J = Analyte was present but the reported value may not be accurate or precise (estimated).
- R = Analyte result was unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
- U = Analyte was not detected at the specified detection limit.
- UJ = Analyte was not detected and the specified detection limit may not be accurate or precise (estimated).

## **FINDINGS**

The summaries of the data validation findings are contained in the following subsections and Table C-2.

## **Holding Times**

All holding-time criteria were met. No holding time flags were applied.

## **Calibration**

Initial and continuing calibrations were analyzed as required in every analytical batch and were in control. No calibration flags were applied.

## **Method Blanks**

Method blanks were analyzed at the required frequency. No method blank flags were applied.

## **Field Blanks**

Equipment blanks were collected and analyzed at the required frequency. No field blank flags were applied.

## **Field Duplicates**

Field duplicates were collected as required, and precision was acceptable. No field duplicate flags were applied.

## **Matrix Spike Samples**

Matrix spike/matrix spike duplicates were not required for these samples in accordance with the SPEIM QAPP.

## **Surrogates**

Surrogate recoveries met each method SPEIM QAPP criteria overall. Surrogate recoveries were less than the lower control limit for method E504.1 in three samples. Two detected results and one non-detected result were qualified as estimated and flagged “J” and “UJ”.

## **Laboratory Control Samples**

Laboratory control sample/laboratory control sample duplicates (LCS/LCSD) were analyzed as required and in control. No LCS flags were applied.

## **Confirmation Results**

Confirmation samples were analyzed as required by method E504.1. EDB had confirmation precision exceeded for one detected result. The detected result was qualified as estimated and flagged “J”.

## **Chain of Custody**

No chain of custody anomalies were noted in the review.

## **Overall Assessment**

The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decision-making process. The procedures for assessing the precision, accuracy, representativeness, completeness, and comparability parameters (PARCC) are addressed in the SPEIM QAPP. The following summary highlights the PARCC findings for the above-defined events:

1. The completeness goal for valid usable data is 95 percent for aqueous samples. Completeness for aqueous samples was 100 percent.
2. The routinely acceptable performance of field and laboratory QC indicators (field duplicates, field blanks, laboratory blanks, surrogate spikes, LCS, and calibrations) shows that the precision and accuracy of the data met project objectives.
3. Sample results are representative and comparable to field conditions and past historical data because the field sampling and laboratory analyses were performed using standardized and documented procedures as defined in project documents. In addition, all results were reported with industry standard units.

**Table C-2  
Validation Flags<sup>a</sup>**

Field ID	Method	Analyte	Final Result (µg/L)	Final Flag	Reason
CHTB01041-M0912	E504.1	1,2-Dibromoethane (EDB)	0.012	J	CF>RPD
CHPD0106C-A0912	E504.1	1,2-Dibromoethane (EDB)	0.098	J	Sur<LCL
CHPV00001-A0412	E504.1	1,2-Dibromoethane (EDB)	0.005	UJ	Sur<LCL
CHTB01001-M1212	E504.1	1,2-Dibromoethane (EDB)	0.194	J	Sur<LCL

<sup>a</sup> Field samples and field duplicates only.

Table sorted by Reason, Analyte and Field ID.

**Key:**

CF>RPD = Confirmation Precision Exceeded

J = estimated

Sur<LCL = Surrogate recovery less than lower limit

UJ = estimated non-detection

µg/L = micrograms per liter

**Attachment C**  
**Analytical Laboratory Results, January - December 2012**  
**FS-12 2012 Summary Letter Report**

Location	Date	Sample ID	Depth	Type	Matrix	Test	Prep	Analyte	Result	DL	RL	Units	Qual
90DP0003	9/12/2012	CHPD00003-A0912DIF	211	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90DP0006	9/25/2012	CHPD00006-A0912	157.4	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.109	0.005	0.01	µg/L	
90DP0009	9/12/2012	CHPD00009-A0912	155	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.182	0.005	0.01	µg/L	
90DP1003	9/13/2012	CHPD01003-A0912	155.6	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.208	0.005	0.01	µg/L	
90EW0017	1/9/2012	CHTB00017-ON5.1	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.223	0.01	0.02	µg/L	
90EW0017	1/11/2012	CHTB00017-ON5.2	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.109	0.005	0.01	µg/L	
90EW0017	1/17/2012	CHTB00017-ON5.3	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.084	0.005	0.01	µg/L	
90EW0017	1/23/2012	CHTB00017-ON5.4	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	µg/L	
90EW0017	2/6/2012	CHTB00017-ON5.5	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.088	0.005	0.01	µg/L	
90EW0017	9/4/2012	CHTB00017-ON6.1	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.535	0.024	0.05	µg/L	
90EW0017	10/3/2012	CHTB00017-ON6.2	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.117	0.005	0.01	µg/L	
90EW0017	11/6/2012	CHTB00017-ON7.1	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.626	0.025	0.05	µg/L	
90EW0017	12/5/2012	CHTB00017-ON7.2	195.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.138	0.005	0.01	µg/L	
90EW0019	4/20/2012	CHPD10019-S0412	197.85	FD1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.407	0.01	0.02	µg/L	
90EW0019	4/20/2012	CHPD00019-S0412	197.85	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.422	0.01	0.02	µg/L	
90EW0019	9/14/2012	CHPD00019-S0912	197.85	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.334	0.01	0.02	µg/L	
90EW0024	9/7/2012	CHPD00024-A0912	159.8	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90EW0025	4/20/2012	CHPD00025-S0412	193.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	µg/L	
90EW0025	9/14/2012	CHPD00025-S0912	193.74	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.092	0.005	0.01	µg/L	
90EW0026	4/20/2012	CHPD00026-S0412	194.9	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.384	0.01	0.02	µg/L	
90EW0026	9/14/2012	CHPD00026-S0912	194.9	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.337	0.009	0.02	µg/L	
90EW0031	4/20/2012	CHPD00031-S0412	106.53	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.056	0.005	0.01	µg/L	
90EW0031	9/14/2012	CHPD00031-S0912	106.53	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.043	0.005	0.01	µg/L	
90MP0060B	9/13/2012	CHPD0060B-A0912	152.27	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.09	0.005	0.01	µg/L	
90MW0027	9/10/2012	CHPD00027-A0912DIF	165.63	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	J
90MW0040	9/14/2012	CHPD10040-A0912	190.09	FD1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.644	0.024	0.05	µg/L	
90MW0040	9/14/2012	CHPD00040-A0912	190.09	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.636	0.024	0.05	µg/L	
90MW0050	9/10/2012	CHPD00050-A0912DIF	88.2	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0055	9/7/2012	CHPD00055-A0912	221.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	27.3	0.969	1.94	µg/L	
90MW0079B	9/10/2012	CHPD0079B-A0912DIF	188.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0079C	9/10/2012	CHPD0079C-A0912DIF	222.5	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0100A	9/10/2012	CHPD0100A-A0912DIF	157.41	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0100B	9/10/2012	CHPD0100B-A0912DIF	102.32	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0106A	9/24/2012	CHPD0106A-A0912	224.92	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.019	0.005	0.01	µg/L	
90MW0106B	9/24/2012	CHPD0106B-A0912	212.33	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	1.02	0.048	0.10	µg/L	
90MW0106C	9/24/2012	CHPD0106C-A0912	192.24	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.098	0.005	0.01	µg/L	J
90MW0107A	9/10/2012	CHPD0107A-A0912DIF	206.9	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.02	0.005	0.01	µg/L	
90MW0200C	9/10/2012	CHPD0200C-A0912DIF	187.55	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.087	0.005	0.01	µg/L	
90MW0201B	9/10/2012	CHPD0201B-A0912DIF	202.69	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	1.19	0.051	0.10	µg/L	
90MW0201C	9/10/2012	CHPD0201C-A0912DIF	182.54	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90MW0202C	9/10/2012	CHPD0202C-A0912DIF	142.54	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.071	0.005	0.01	µg/L	
90MW0203A	9/10/2012	CHPD0203A-A0912DIF	202.02	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.057	0.005	0.01	µg/L	
90MW0206B	9/25/2012	CHPD0206B-A0912DIF	191.84	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	22	1	2.00	µg/L	
90MW0209A	9/13/2012	CHPD0209A-A0912	163.07	N1	WG	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01001	1/30/2012	CHTB01001-M0212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.281	0.01	0.02	µg/L	
90PLT01001	2/29/2012	CHTB01001-M0312	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.305	0.01	0.02	µg/L	

**Attachment C**  
**Analytical Laboratory Results, January - December 2012**  
**FS-12 2012 Summary Letter Report**

Location	Date	Sample ID	Depth	Type	Matrix	Test	Prep	Analyte	Result	DL	RL	Units	Qual
90PLT01001	3/27/2012	CHTB01001-M0412	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.299	0.01	0.02	µg/L	
90PLT01001	4/26/2012	CHTB01001-M0512	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.263	0.01	0.02	µg/L	
90PLT01001	5/29/2012	CHTB01001-M0612	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.213	0.005	0.01	µg/L	
90PLT01001	6/28/2012	CHTB01001-M0712	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.228	0.01	0.02	µg/L	
90PLT01001	7/18/2012	CHTB01001-M0812	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.248	0.01	0.02	µg/L	
90PLT01001	8/28/2012	CHTB01001-M0912	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.218	0.005	0.01	µg/L	
90PLT01001	9/27/2012	CHTB01001-M1012	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.253	0.01	0.02	µg/L	
90PLT01001	10/25/2012	CHTB01001-M1112	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.203	0.005	0.01	µg/L	
90PLT01001	11/28/2012	CHTB01001-M1212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.194	0.005	0.01	µg/L	J
90PLT01001	12/26/2012	CHTB01001-M0113	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.155	0.005	0.01	µg/L	
90PLT01023	1/30/2012	CHTB01023-M0212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012	0.005	0.01	µg/L	
90PLT01024	2/29/2012	CHTB01024-M0312	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	3/27/2012	CHTB01024-M0412	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	4/26/2012	CHTB01024-M0512	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	5/29/2012	CHTB01024-M0612	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	6/28/2012	CHTB01024-M0712	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	7/18/2012	CHTB01024-M0812	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	8/28/2012	CHTB01024-M0912	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	9/27/2012	CHTB01024-M1012	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	10/25/2012	CHTB01024-M1112	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	11/28/2012	CHTB01024-M1212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01024	12/26/2012	CHTB01024-M0113	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	1/30/2012	CHTB01033-M0212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	2/29/2012	CHTB01033-M0312	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	3/27/2012	CHTB01033-M0412	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	4/26/2012	CHTB01033-M0512	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	5/29/2012	CHTB01033-M0612	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	6/28/2012	CHTB01033-M0712	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	7/18/2012	CHTB01033-M0812	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	8/28/2012	CHTB01033-M0912	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	9/27/2012	CHTB01033-M1012	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	10/25/2012	CHTB01033-M1112	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	11/28/2012	CHTB01033-M1212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01033	12/26/2012	CHTB01033-M0113	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	1/30/2012	CHTB01041-M0212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	2/29/2012	CHTB01041-M0312	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	3/27/2012	CHTB01041-M0412	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	4/26/2012	CHTB01041-M0512	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	5/29/2012	CHTB01041-M0612	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	6/28/2012	CHTB01041-M0712	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01041	7/18/2012	CHTB01041-M0812	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	BRL	0.005	0.01	µg/L	J
90PLT01041	8/28/2012	CHTB01041-M0912	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	0.012	0.005	0.01	µg/L	J
90PLT01042	9/27/2012	CHTB01042-M1012	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01042	10/25/2012	CHTB01042-M1112	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01042	11/28/2012	CHTB01042-M1212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01042	12/26/2012	CHTB01042-M0113	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U

**Attachment C**  
**Analytical Laboratory Results, January - December 2012**  
**FS-12 2012 Summary Letter Report**

Location	Date	Sample ID	Depth	Type	Matrix	Test	Prep	Analyte	Result	DL	RL	Units	Qual
90PLT01053	1/30/2012	CHTB01053-M0212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	2/29/2012	CHTB01053-M0312	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	3/27/2012	CHTB01053-M0412	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	4/26/2012	CHTB01053-M0512	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	5/29/2012	CHTB01053-M0612	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	6/28/2012	CHTB01053-M0712	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	7/18/2012	CHTB01053-M0812	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	8/28/2012	CHTB01053-M0912	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	9/27/2012	CHTB01053-M1012	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	10/25/2012	CHTB01053-M1112	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	11/28/2012	CHTB01053-M1212	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90PLT01053	12/26/2012	CHTB01053-M0113	NA	N1	WW	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U
90SW0001	4/11/2012	CHPV00001-A0412	NA	N1	WS	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	UJ
90SW0002	4/11/2012	CHPV00002-A0412	NA	N1	WS	E504.1	METHOD	1,2-DIBROMOETHANE (ETHYLENE DIBROMIDE)	ND	0.005	0.01	µg/L	U

Data Source: AFCEC, March 2013, MMR-AFCEC Data Warehouse

**Key:**


BRL = below reporting limit	RL = reporting limit
DL = detection limit	U = undetected
FD1 = field duplicate	UJ = estimated nondetect
J = estimated value	WG = groundwater
MS = matrix spike	WS = surface water
NA = not applicable	WW = wastewater
ND = nondetect	µg/L = micrograms per liter
N1 = native sample	


**ATTACHMENT D**

**FS-12 Project Notes**


**Solar Powered Pumping Cost Evaluation**  
**420005-SPEIM-FS12-PRJNOT-002**

**FS-12 2011 Annual SPEIM Data Presentation**  
**(May 2010 through November 2011)**  
**420005-SPEIM-FS12-PRJNOT-003**


  <b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>PROJECT NOTE</b>		TASK ORDER 0300
			PROJECT NO. 420005
	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-002</b> <b>CDRL A001k</b>		PAGE 1 OF 3

Confirmation Of: <input type="checkbox"/> Meeting <input type="checkbox"/> Change Notice <input checked="" type="checkbox"/> General Project Note  Subject: <b>SOLAR POWERED PUMPING COST EVALUATION</b>  EPA OU# 01-GW PLUMES/FS-12	Date Held: Not Applicable Location: Not Applicable Date Issued: 16 July 2012 Recorded By: Mark Hilyard  Issued By: Nigel Tindall   <hr/> CH2M HILL TECHNICAL SERVICES GROUP MANAGER
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ITEM	REMARKS
<b>1.0</b>	<b>INTRODUCTION</b>  <p>This project note presents a cost analysis for installation and operation of a solar powered groundwater pump within an existing 2-inch diameter groundwater monitoring well at an Air Force Center for Engineering and the Environment (AFCEE) Installation Restoration Program (IRP) plume at Massachusetts Military Reservation (MMR) on Cape Cod, Massachusetts. The intent of this analysis is to estimate the potential cost savings associated with installing a solar array (compared to use of traditional grid-supplied electricity) to power a groundwater pump installed within an existing 2-inch diameter groundwater monitoring well. The extraction of contaminated groundwater from monitoring wells could potentially be used to augment mass removal and/or improve aquifer restoration timeframes associated with existing groundwater pump and treat systems at MMR because many of the existing monitoring wells are screened in areas of the aquifer characterized by high concentrations of the contaminants of concern (i.e., hot spots) that may be distal from an extraction well.</p> <p>This cost evaluation does not determine the efficacy of this technology at achieving remedial objectives for a given IRP groundwater plume (i.e., mass removal or improved restoration timeframes). However, it may be used to support a traditional feasibility analysis regarding application of this technology and its potential to improve remedial timeframes at various IRP plumes as hot spots are identified through the AFCEE System Performance and Ecological Impact Monitoring (SPEIM) program at MMR.</p>
<b>2.0</b>	<b>SITE SELECTION</b>  <p>For the purposes of this cost evaluation groundwater monitoring well 90MW0106B, which is located at the Fuel Spill-12 (FS-12) groundwater plume, was selected. This well was selected because it is of typical construction (2-inch diameter, poly-vinyl chloride casing) that is screened within typical formation (moderately to well sorted medium to fine sands) and is screened at a depth in the aquifer that is typical of many monitoring wells at the MMR (210-215 feet below ground surface [ft bgs]). Depth to water in this well is approximately 75 ft bgs. Additionally, this well is expected to draw in appreciable ethylene dibromide (EDB) concentrations (greater than 0.1 microgram per liter) for up to 15 years.</p>

  <b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>PROJECT NOTE</b>		TASK ORDER 0300
			PROJECT NO. 420005
	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-002</b> <b>CDRL A001k</b>		PAGE 2 OF 3

ITEM	REMARKS
	<p>Lastly, because this monitoring well is located in an undeveloped area that is also near existing treatment plant influent pipeline, the power requirements associated with either tying into existing pipeline or wellhead treatment at the surface with granular activated carbon [GAC]) were included in this evaluation.</p>
<b>3.0</b>	<b>COST EVALUTION</b>
<b>3.1</b>	<p><b>Selection of Technology</b></p> <p>Use of a photovoltaic array to power Grundfos Readiflo 2™ pumps was evaluated for this cost analysis. Off-the-shelf solar/wind powered pump systems, such as the Grundfos SQFlex system™, were initially identified for cost analysis. However, these systems have pumps with a minimum diameter of 3-inches, making them unavailable for installation into the typical 2-inch diameter monitoring wells at MMR. Additionally, because AFCEE already owns numerous Grundfos Readiflo pumps, a photovoltaic system designed to power these pumps would require less upfront capital costs than an off-the-shelf system.</p>
<b>3.2</b>	<p><b>Assumptions</b></p> <p>It is assumed that the pump at 90MW0106B will receive 100% of its electrical power from the photovoltaic array at the surface. This solar powered extraction system is intended solely to augment the existing groundwater pump and treat system (and is not considered critical to achieving the Remedial Action Objectives for FS-12). Therefore, intermittent operation of the solar powered pump (approximately 30% of the time, based on availability of solar power in this region) at 90MW0106B is allowable and there is no need for backup batteries. In order to estimate the costs associated with tying into the electrical grid, it was assumed that monitoring well 90MW0106B is located approximately 50 feet from an existing electrical power source. Lastly, this cost evaluation does not take into account any incentive or rebate plans for renewable energy that may be offered by local electrical suppliers.</p> <p>This cost analysis considered the power requirements, capital costs and electrical cost savings (compared to grid-based power) associated with photovoltaic arrays required to power pumps operating at various flow rates that would typically be achieved at 2-inch diameter monitoring wells (1 to 20 gallons per minute [gpm]). Each scenario assumed a 30-year remedy duration. Also, the additional power requirements associated with pumping extracted water through GAC units at the surface (vs. tying into an existing influent pipeline) were also included.</p> <p>This cost evaluation was based on evaluations performed using the “United States Air Force (USAF) Tool for Evaluating Clean Solar and Wind Energy in Environmental Programs” (CleanSWEEP). CleanSWEEP is a Microsoft Excel® (MS Excel) spreadsheet tool that enables users to evaluate the impacts of wind and/or solar photovoltaic (PV) resources to run small environmental remediation systems (i.e., less than 20 kilowatts [kW]). This tool was developed for the USAF under a subcontract through Concurrent Technologies Corporation (CTC) and the USAF Research Laboratory at Wright-Patterson Air Force Base (AFB).</p>

  <b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>PROJECT NOTE</b>		TASK ORDER 0300
			PROJECT NO. 420005
	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-002</b> <b>CDRL A001k</b>		PAGE 3 OF 3

ITEM	REMARKS
	<p>Users input site-specific data such as location and hydrogeological data, existing or new system energy requirements, and the estimated time to system shutdown. From this data, the tool provides potential wind and solar options for the site, estimates a conversion cost, and calculates the return on investment timeframe under several future energy price scenarios. The tool also can be used to identify sites and remediation systems that are not good candidates for solar and wind energy.</p> <p>As this tool was initially developed for the USAF, it has been pre-populated with data specific to all Continental U.S. (CONUS) active USAF bases. It is intended to function as a stand-alone decision and design tool for small to mid-sized systems (e.g., less than 20 kW) and may be used as an initial screening tool for larger systems.</p> <p>The tool uses industry published values for renewable energy potential and costs. Information available from the U.S. Department of Energy (DoE) National Renewable Energy Laboratory (NREL) was relied upon heavily during the development of CleanSWEEP.</p>
<b>4.0</b>	<p><b>RESULTS/CONCLUSIONS</b></p> <p>A summary of the power and size requirements for solar powered systems that pump between 1 to 20 gpm (with or without use of GAC treatment) is provided in Table 1. In addition, a comparison of estimated capital, energy, and operations and maintenance (O&amp;M) costs associated with grid-powered versus solar powered scenarios is provided in Table 1. Lastly, Table 1 also provides a summary of the potential reductions in air emissions (CO<sub>2</sub>) that would be achieved by application of solar powered pumping. Screen-shots of the CleanSWEEP input and output screens for the various scenarios are provided in Attachment A.</p> <p>This cost evaluation does not factor the potential savings (electrical and O&amp;M) that may be realized if the operation of the existing groundwater pump and treat system can be reduced through implementation of this technology at existing monitoring wells.</p> <p>In general, over a thirty year remedial action, the estimated capital and O&amp;M costs associated with a solar-powered pumping system are significantly less than the costs associated with a grid-powered pumping system. It is noted that actual costs associated with tying into and purchasing grid power is site specific and ultimately dependant on the remoteness of the proposed site and electrical rates at the time of the remedy. However, the information presented in the cost analysis can be used to estimate the size of a solar panel array that is needed for a range of flow rates with or without GAC treatment at the wellhead.</p>

Attachments:

Table 1. Summary of Energy Requirements, Costs, and Potential Air Emission Reductions for Various Solar Powered Arrays

Attachment 1: Screen Shots – CleanSWEEP Simulation Screen Captures

**Table 1**  
**Summary of Energy Requirements, Costs, and Potential Air Emission Reductions for Various Solar Powered Arrays**  
**FS-12 Solar Powered Pumping Project Note**

Flow (gpm)	GAC?	Head (feet water)	Energy Requirement (kWh/yr)	Grid Scenario			Solar Scenario				Difference in Total Cost (\$)**	CO2 Reduction (tons/yr)
				Capital Cost (\$)	Energy Cost * (\$)	Total Cost* (\$)	Area Required (m <sup>2</sup> )	Capital Cost (\$)	O&M Cost (\$)	Total Cost (\$)		
1	Yes	86.5	71	\$12,500	\$577	\$13,077	0.39	\$510	\$20	\$530	-\$12,547	36.0
1	No	75	62	\$12,500	\$500	\$13,000	0.33	\$446	\$18	\$464	-\$12,536	31.2
5	Yes	86.5	357	\$12,500	\$2,885	\$15,385	1.93	\$2,326	\$102	\$2,428	-\$12,957	179.9
5	No	75	309	\$12,500	\$2,502	\$15,002	1.67	\$2,033	\$88	\$2,121	-\$12,881	156.0
10	Yes	92.3	761	\$12,500	\$6,157	\$18,657	4.12	\$4,751	\$217	\$4,968	-\$13,689	383.9
10	No	75	619	\$12,500	\$5,003	\$17,503	3.35	\$3,907	\$177	\$4,084	-\$13,419	312.0
20	Yes	92.3	1523	\$12,500	\$12,314	\$24,814	8.24	\$9,130	\$435	\$9,565	-\$15,249	767.8
20	No	75	1237	\$12,500	\$10,006	\$22,506	6.7	\$7,508	\$353	\$7,861	-\$14,645	623.9

Data Source: CleanSWEEP Draft Beta version 05-18-12

Notes:

\* Value represents the energy or total costs for the remedy lifetime.

\*\* Negative difference indicates that the solar alternative is less expensive than the grid alternative.

Key:

GAC = granular activated carbon      m<sup>2</sup> = square meters  
gpm = gallons per minute      psig = pounds per square inch gauge  
kWh = kilowatt hour      yr = year

Assumptions:

Depth to groundwater = 75 feet  
GAC option assumes (Calgon products)  
0-10 gpm = 55-gallon drum with pressure 5 psig (11.5 feet water) (Flowsorb)  
10.1-30 gpm = 350-gallon drum with pressure 7.5 psig (17.3 feet water) (Disposorb)  
All electricity provided either by solar or grid (no electricity storage in battery or net metering)  
Operate pump only when adequate solar available (30%)  
Remedy duration = 30 years  
Closest utility drop = 50 feet away  
Cost of electricity via grid = 17 cents per kilowatt hour  
No rebates/incentives available  
All other assumptions used CleanSWEEP defaults

**ATTACHMENT 1**

**Clean SWEEP**

**Simulation Screen Captures**

## **1 GPM with GAC**

# 1 GPM\_with GAC

Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

## Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB		MMR
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	1.00 gpm	.00 scfm	
Head/Pressure	86.50 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.036 HP	0.000 HP	
Equipment Power Rating	0.027 kW	0.000 kW	
Energy Consumption	238 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

## Location and System Input Sheet

## 1 GPM\_with GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 1 GPM\_with GAC

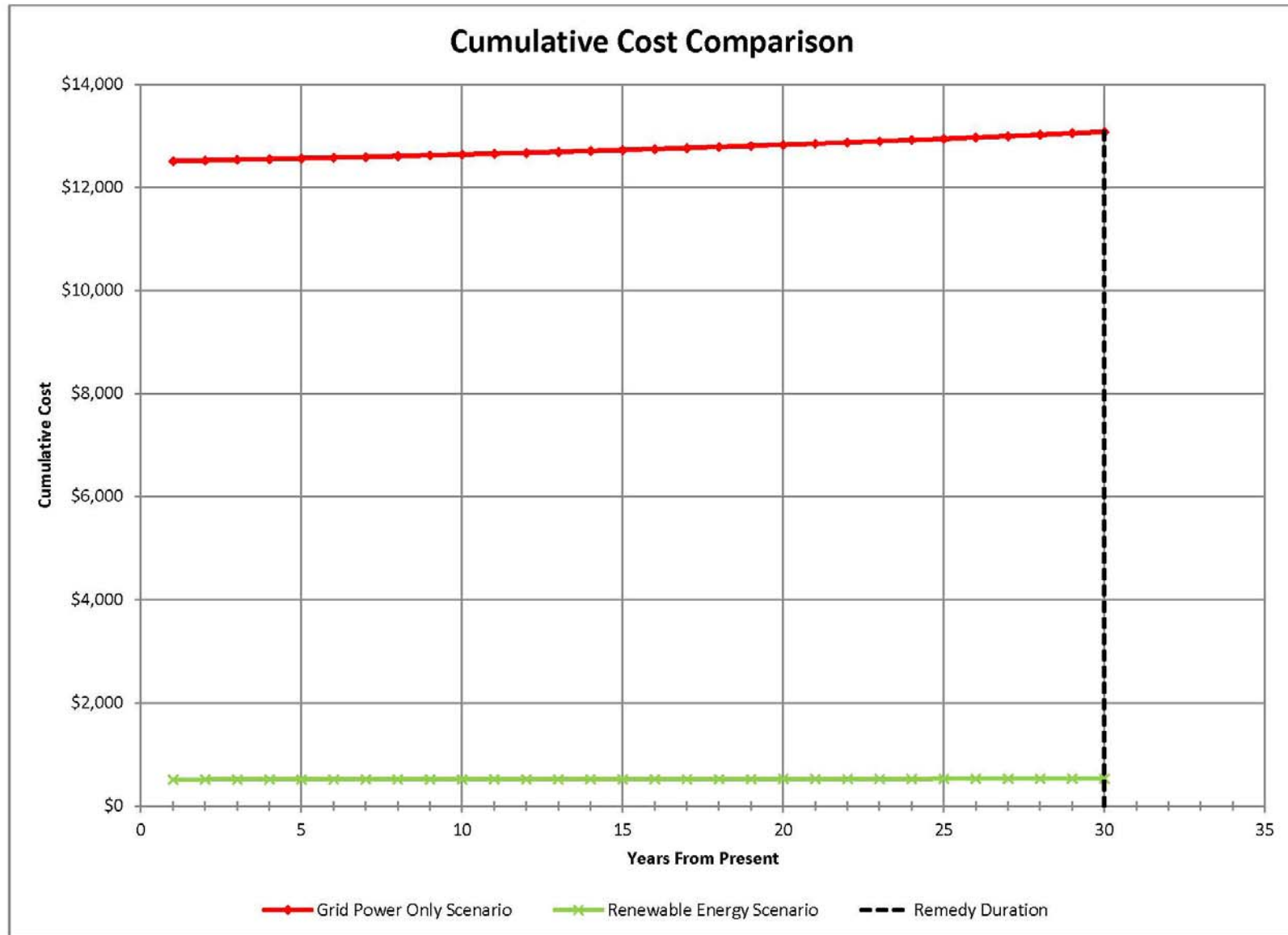
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	71 kWh/yr	0 kWh/yr	0 kWh/yr	71 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.04 kW
Area Required/System Footprint	NA	NA	NA	0.39 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$11,748.26/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$510
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$20
Energy Cost (\$ over remedy lifetime)	\$577	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$13,077	\$531		
Remedy Lifetime Cost Reduction	NA	\$12,546		
Return on Investment	NA	2364%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	1	0	Negligible	Negligible
SOx (tons)	3	0	Negligible	Negligible
CO2 (tons)	1,079	0	0.00	0.08
RECs	0	0	0	2

#### Output Data Sheet

## 1 GPM\_with GAC



**1 GPM no GAC**

# 1 GPM\_No GAC

## Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB	MMR	
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	1.00 gpm	.00 scfm	
Head/Pressure	75.00 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.032 HP	0.000 HP	
Equipment Power Rating	0.024 kW	0.000 kW	
Energy Consumption	206 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

### Location and System Input Sheet

## 1 GPM\_No GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 1 GPM\_No GAC

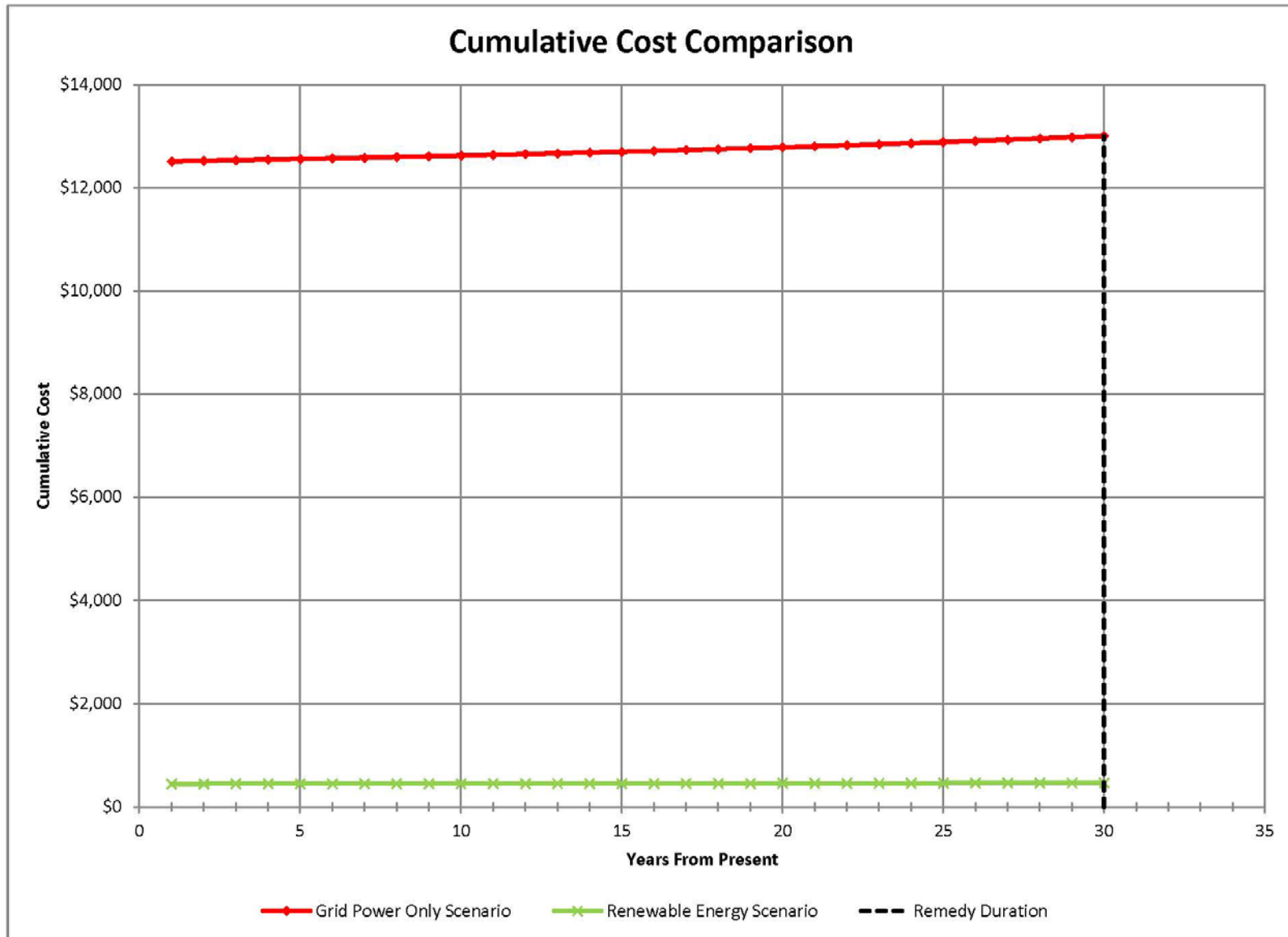
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	62 kWh/yr	0 kWh/yr	0 kWh/yr	62 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.04 kW
Area Required/System Footprint	NA	NA	NA	0.33 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$11,845.20/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$446
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$18
Energy Cost (\$ over remedy lifetime)	\$500	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$13,000	\$464		
Remedy Lifetime Cost Reduction	NA	\$12,537		
Return on Investment	NA	2703%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	1	0	Negligible	Negligible
SOx (tons)	2	0	Negligible	Negligible
CO2 (tons)	936	0	0.00	0.07
RECs	0	0	0	2

#### Output Data Sheet

## 1 GPM\_No GAC



## **5 GPM with GAC**

## 5 GPM\_with GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

#### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB	MMR	
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	5.00 gpm	.00 scfm	
Head/Pressure	86.50 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.182 HP	0.000 HP	
Equipment Power Rating	0.136 kW	0.000 kW	
Energy Consumption	1,189 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

#### Location and System Input Sheet

## 5 GPM\_with GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 5 GPM\_with GAC

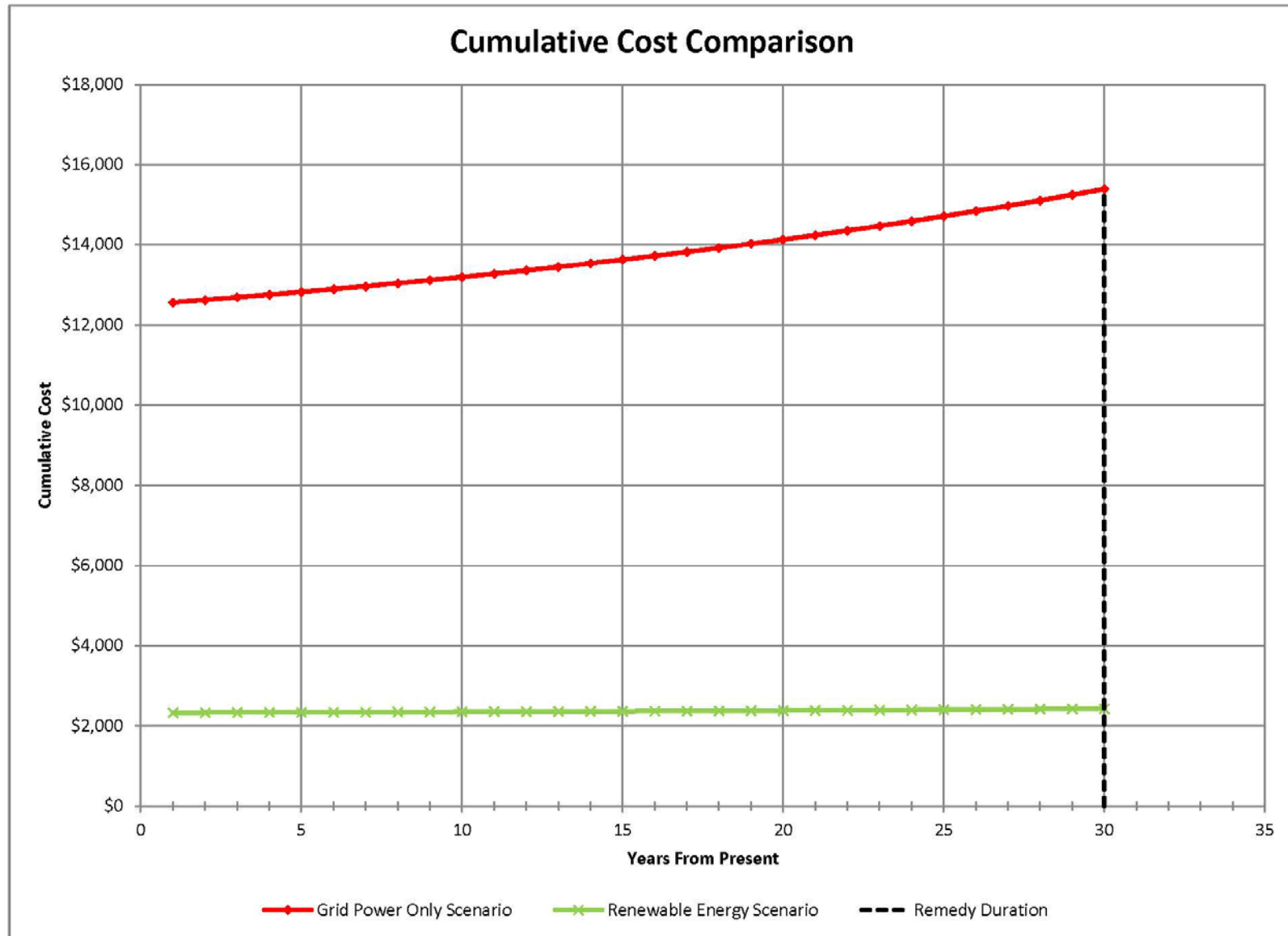
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	357 kWh/yr	0 kWh/yr	0 kWh/yr	357 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.22 kW
Area Required/System Footprint	NA	NA	NA	1.93 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$10,708.11/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$2,326
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$102
Energy Cost (\$ over remedy lifetime)	\$2,885	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$15,385	\$2,427		
Remedy Lifetime Cost Reduction	NA	\$12,958		
Return on Investment	NA	534%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	5	0	Negligible	Negligible
SOx (tons)	14	0	Negligible	Negligible
CO2 (tons)	5,397	0	0.00	0.41
RECs	0	0	0	11

#### Output Data Sheet

## 5 GPM\_with GAC



**5 GPM no GAC**

## 5 GPM\_No GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

#### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB	MMR	
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	5.00 gpm	.00 scfm	
Head/Pressure	75.00 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.158 HP	0.000 HP	
Equipment Power Rating	0.118 kW	0.000 kW	
Energy Consumption	1,031 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

#### Location and System Input Sheet

## 5 GPM\_No GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 5 GPM\_No GAC

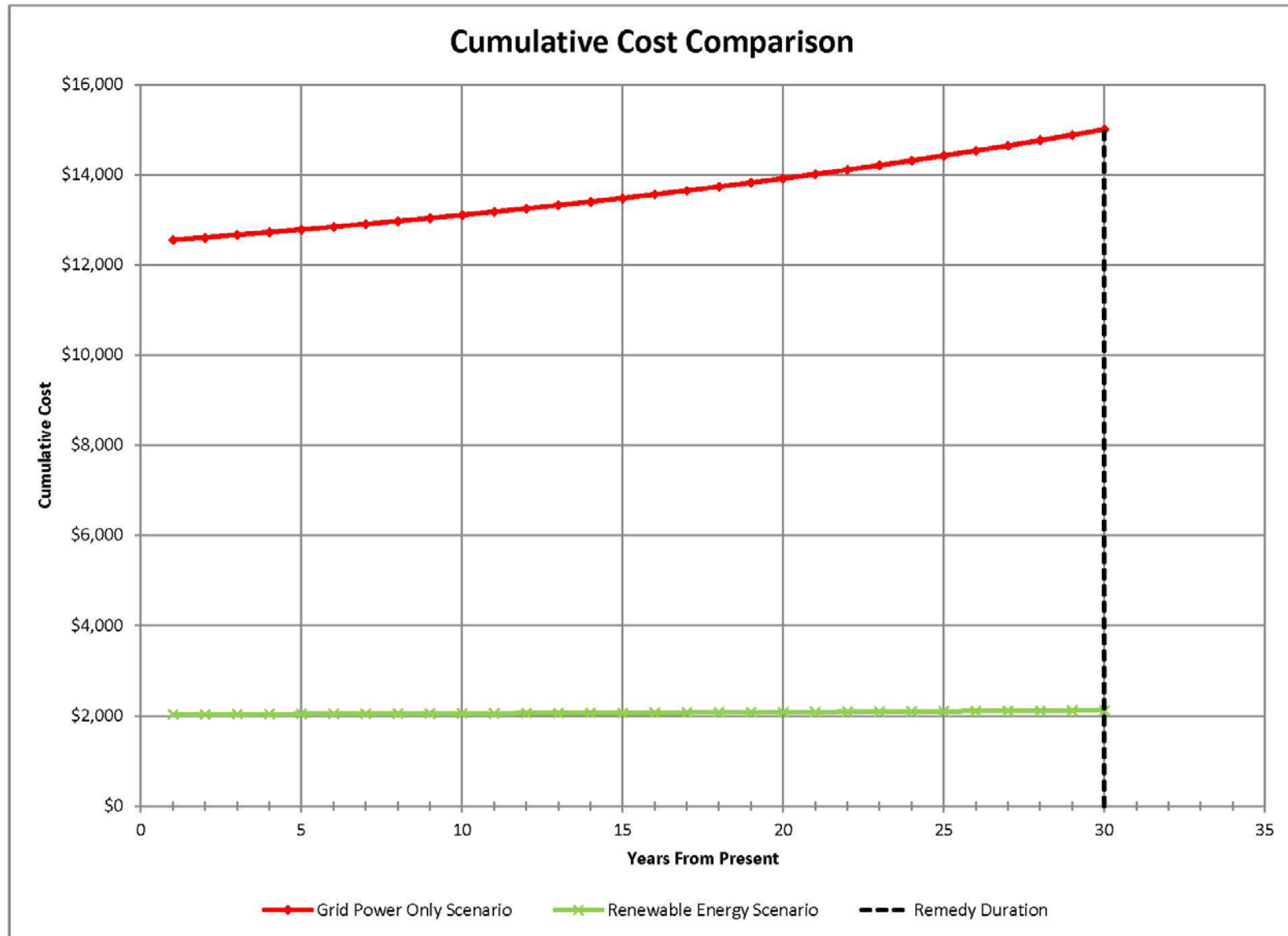
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	309 kWh/yr	0 kWh/yr	0 kWh/yr	309 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.19 kW
Area Required/System Footprint	NA	NA	NA	1.67 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$10,796.46/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$2,033
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$88
Energy Cost (\$ over remedy lifetime)	\$2,502	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$15,002	\$2,121		
Remedy Lifetime Cost Reduction	NA	\$12,880		
Return on Investment	NA	607%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	4	0	Negligible	Negligible
SOx (tons)	12	0	Negligible	Negligible
CO2 (tons)	4,680	0	0.00	0.36
RECs	0	0	0	9

#### Output Data Sheet

## 5 GPM\_No GAC



## **10 GPM with GAC**

## 10 GPM\_with GAC

Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB		MMR
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	10.00 gpm	.00 scfm	
Head/Pressure	92.30 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.388 HP	0.000 HP	
Equipment Power Rating	0.290 kW	0.000 kW	
Energy Consumption	2,538 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

### Location and System Input Sheet

## 10 GPM\_with GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 10 GPM\_with GAC

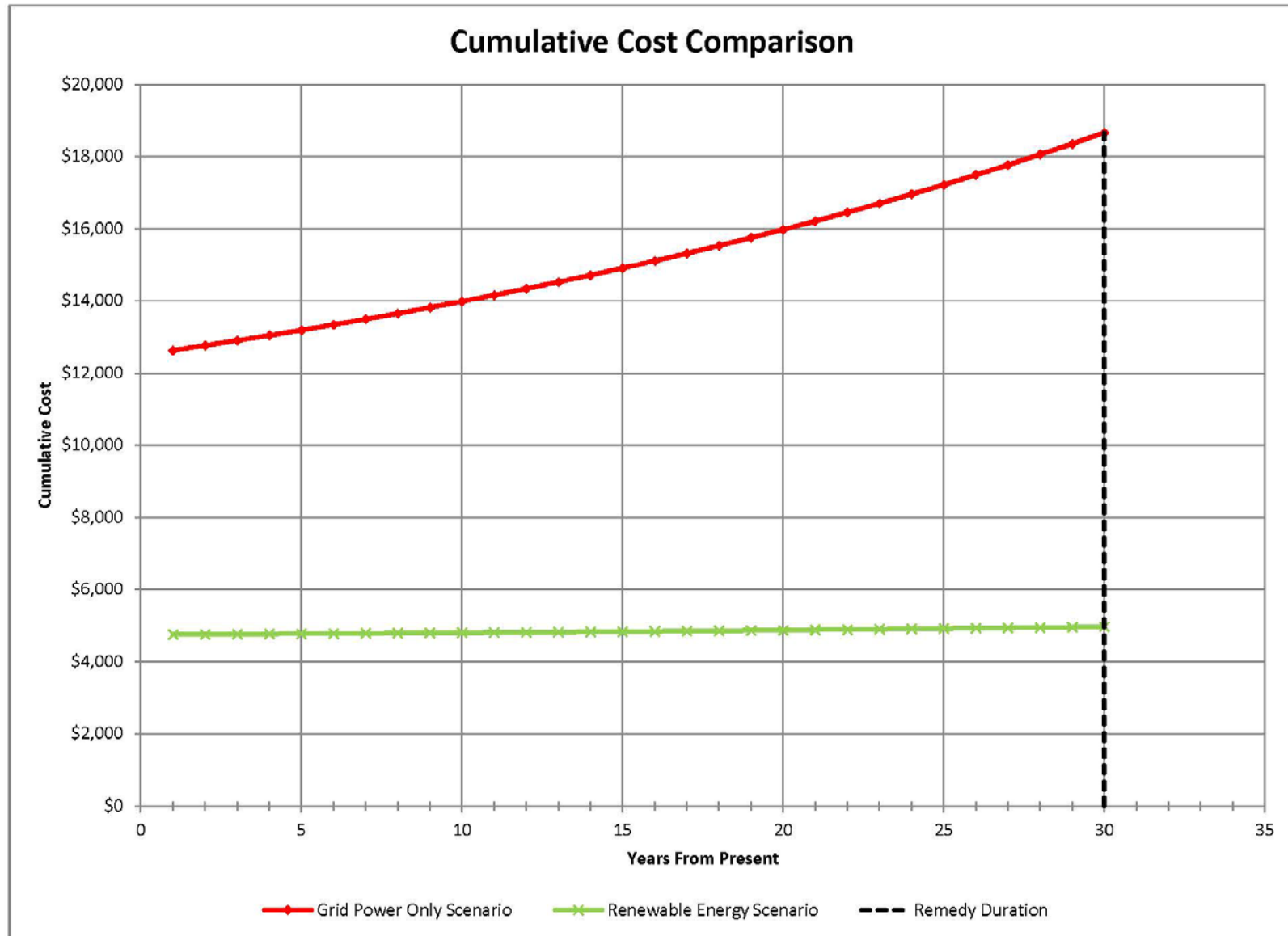
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	761 kWh/yr	0 kWh/yr	0 kWh/yr	761 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.46 kW
Area Required/System Footprint	NA	NA	NA	4.12 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$10,250.62/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$4,751
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$217
Energy Cost (\$ over remedy lifetime)	\$6,157	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$18,657	\$4,968		
Remedy Lifetime Cost Reduction	NA	\$13,689		
Return on Investment	NA	276%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	11	0	Negligible	Negligible
SOx (tons)	29	0	Negligible	Negligible
CO2 (tons)	11,519	0	0.00	0.88
RECs	0	0	0	23

#### Output Data Sheet

## 10 GPM\_with GAC



**10 GPM no GAC**

## 10GPM\_No GAC

Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB	MMR	
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	10.00 gpm	.00 scfm	
Head/Pressure	75.00 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.316 HP	0.000 HP	
Equipment Power Rating	0.235 kW	0.000 kW	
Energy Consumption	2,062 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

### Location and System Input Sheet

## 10GPM\_No GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 10GPM\_No GAC

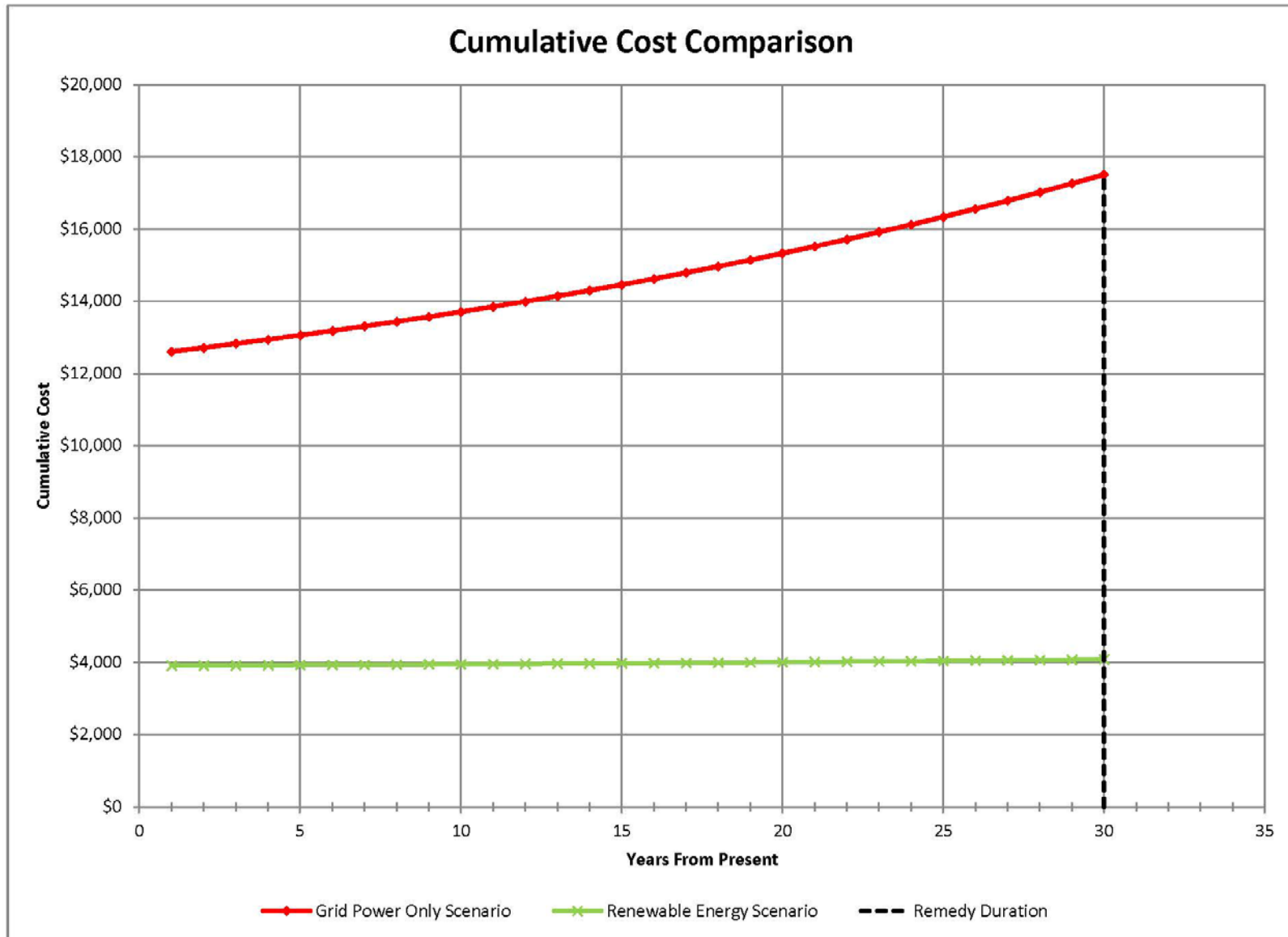
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	619 kWh/yr	0 kWh/yr	0 kWh/yr	619 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.38 kW
Area Required/System Footprint	NA	NA	NA	3.35 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$10,373.90/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$3,907
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$177
Energy Cost (\$ over remedy lifetime)	\$5,003	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$17,503	\$4,084		
Remedy Lifetime Cost Reduction	NA	\$13,420		
Return on Investment	NA	329%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	9	0	Negligible	Negligible
SOx (tons)	24	0	Negligible	Negligible
CO2 (tons)	9,360	0	0.00	0.71
RECs	0	0	0	19

#### Output Data Sheet

## 10GPM\_No GAC



## **20 GPM with GAC**

## 20 GPM\_with GAC

Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB		MMR
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	20.00 gpm	.00 scfm	
Head/Pressure	92.30 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.777 HP	0.000 HP	
Equipment Power Rating	0.579 kW	0.000 kW	
Energy Consumption	5,075 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

### Location and System Input Sheet

## 20 GPM\_with GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 20 GPM\_with GAC

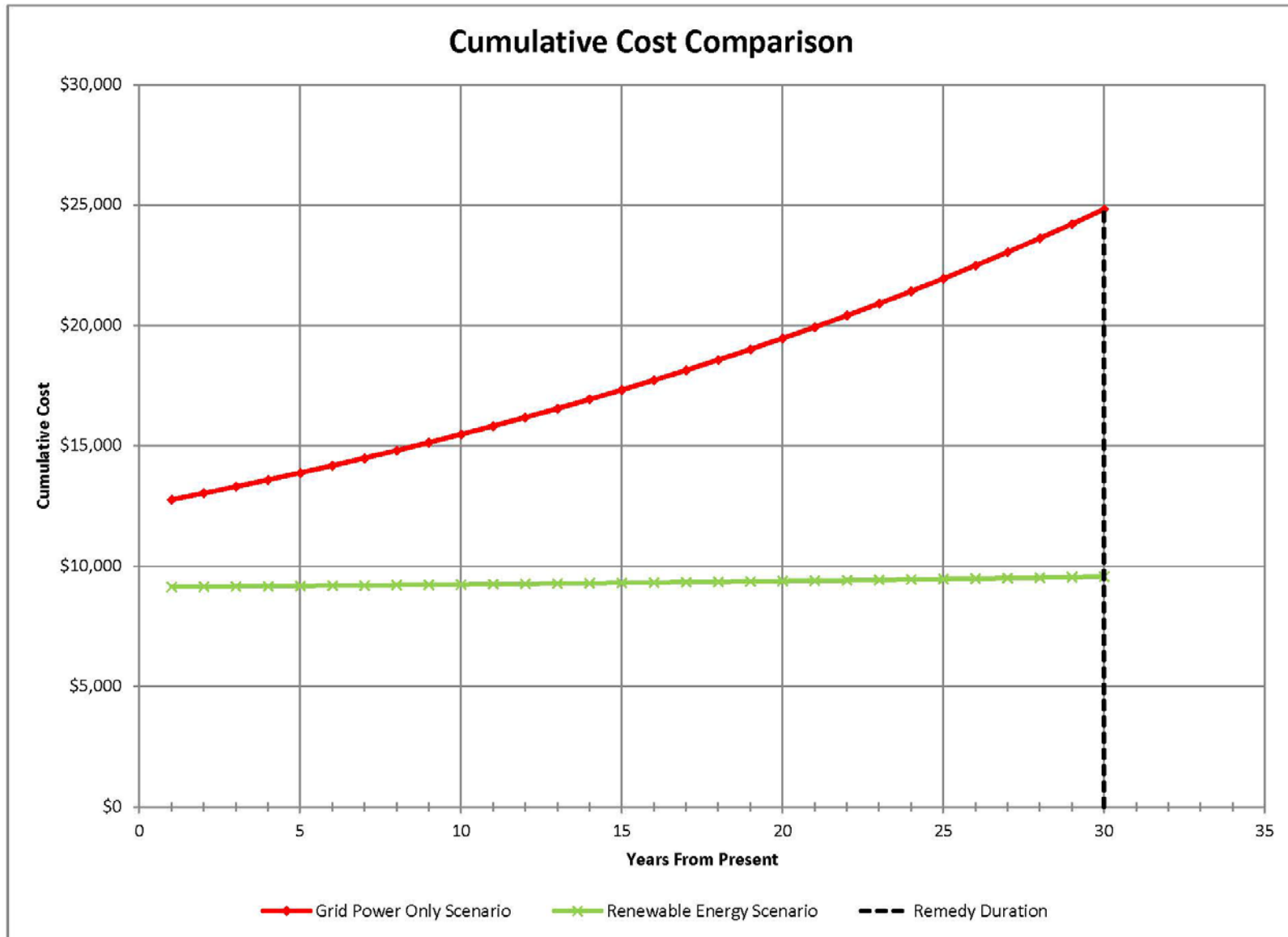
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Output Data Sheet

MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	1,523 kWh/yr	0 kWh/yr	0 kWh/yr	1,523 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.93 kW
Area Required/System Footprint	NA	NA	NA	8.24 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$9,849.42/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$9,130
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$435
Energy Cost (\$ over remedy lifetime)	\$12,314	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$24,814	\$9,565		
Remedy Lifetime Cost Reduction	NA	\$15,249		
Return on Investment	NA	159%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	21	0	Negligible	Negligible
SOx (tons)	59	0	Negligible	Negligible
CO2 (tons)	23,037	0	0.00	1.76
RECs	0	0	0	46

#### Output Data Sheet

## 20 GPM\_with GAC



**20 GPM no GAC**

## 20 GPM\_No GAC

Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

Tool Reset

### Location and System Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values		User-Defined Values
Current Year	2012		
Location	Otis AFB	MMR	
Zip Code	02542		
Site Name	90MW0106B		
Elevation (ft above sea level)	131 ft amsl		
Is this a new system?	Yes		
If Yes, is grid power available at the system?	No		
If No, distance to nearest electrical access (ft)	50 ft		
Cost to bring in electrical (\$)	\$12,500		
System Energy Requirement	Water Components	Air Components	
Flow Rate	20.00 gpm	.00 scfm	
Head/Pressure	75.00 ft	.00 inches H2O	
Total Horsepower of all Equipment	0.631 HP	0.000 HP	
Equipment Power Rating	0.471 kW	0.000 kW	
Energy Consumption	4,124 kWh/yr		
Percent Energy to be Provided by Renewables (%)	100.0%		
Increasing/Decreasing Energy Requirements (%/year)	0.0% per year		
Is continuous operation required?	No		
If no, minimum required operation time (%/year)	30% per year		
Expected Remedy Duration (years beyond current)	30.00 years		

### Location and System Input Tab

## 20 GPM\_No GAC

### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)

#### Energy Input Sheet

MMR: Site 90MW0206A	Pre-Defined Values	User-Defined Values
Grid Energy Detail		
Provider	Commonwealth Electric Co - MA	
Billing Structure	Commercial	
Projected Energy Inflation Rate (%/yr)	3.00%	
Current Year Energy Cost (cents/kWh)	16.33¢/kWh	17.00¢/kWh
Emissions		
NOx (lbs/MWh)	0.86 lbs/MWh	
SOx (lbs/MWh)	2.36 lbs/MWh	
CO2 (lbs/MWh)	928 lbs/MWh	
Incentives/Rebates	\$0 remedy lifetime	
Renewable Energy Detail		
Solar PV		
Solar Panel Efficiency (%)	15%	
Mount Type	Fixed, Tilt at Latitude	
Potential (kWh/m2/day)	4.5 kWh/m2/day	
Wind		
Wind Speed Reference Height (m)		
Reference Wind Speed (m/s)		
Maximum Hub Height (m)	10 m	
Wind Regime	Inland Site	
Surface Obstructions	Rough terrain	

#### Energy Input Sheet

## 20 GPM\_No GAC

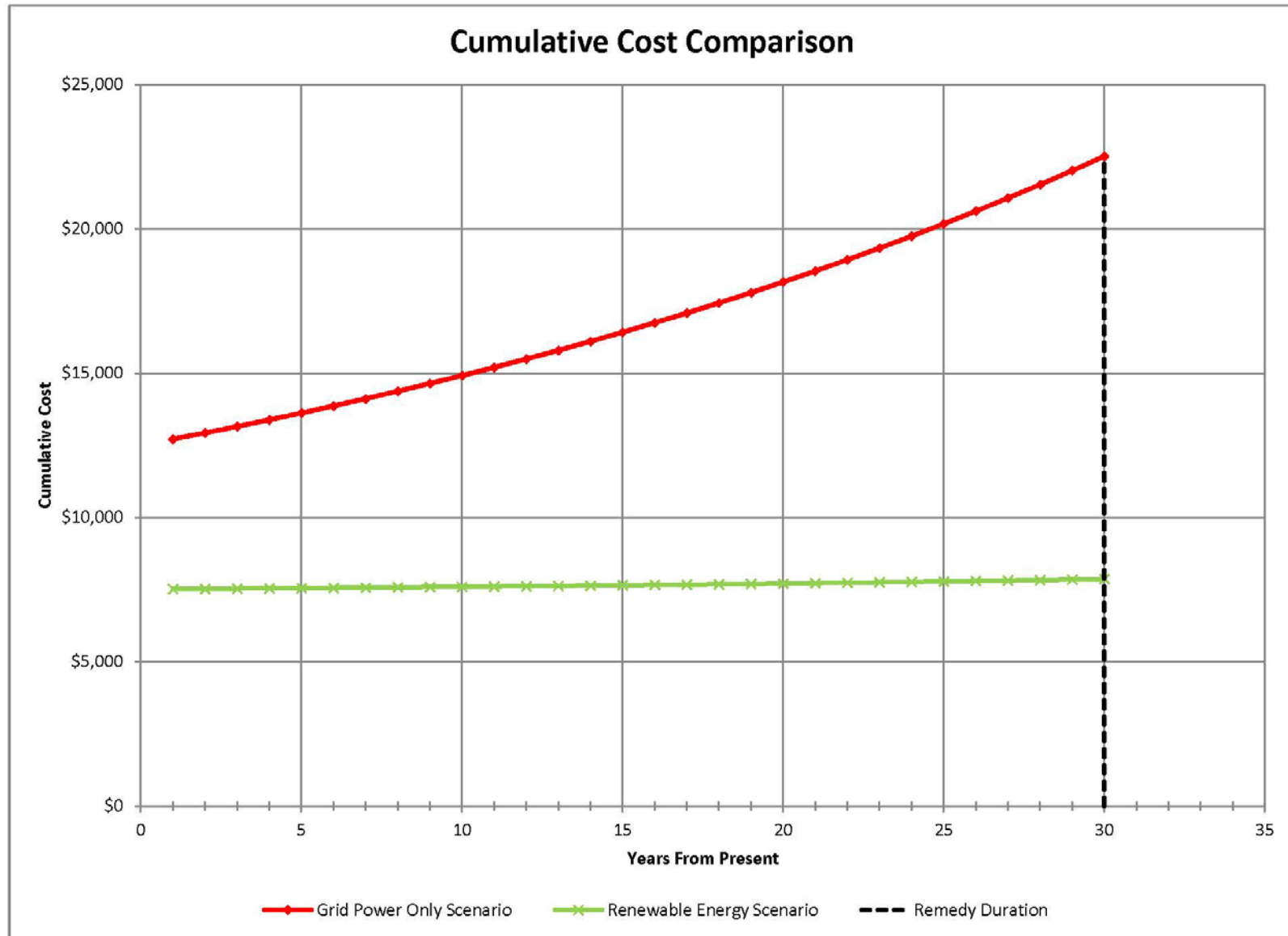
### Clean Solar and Wind Energy in Environmental Programs (Clean SWEEP)


#### Output Data Sheet


MMR: Site 90MW0206A	Grid Only (Baseline)	Renewable Energy Scenario		
		Grid	Wind	Solar PV
Energy Overview				
Percentage Desired from Wind or Solar (%)	NA	NA	0%	100%
Energy Requirement - Baseyear (kWh/yr)	1,237 kWh/yr	0 kWh/yr	0 kWh/yr	1,237 kWh/yr
Renewable Energy Power Rating (kW)	NA	NA	NA	0.75 kW
Area Required/System Footprint	NA	NA	NA	6.7 m2
% Energy Provided	100%	0%	0%	100%
Cost Analysis				
Cost per Watt for Renewable (\$/kW)	NA	NA	NA	\$9,967.88/kW
Capital Cost (\$)	\$12,500	\$0	NA	\$7,508
O&M Cost (\$ over remedy lifetime)	NA	NA	NA	\$353
Energy Cost (\$ over remedy lifetime)	\$10,006	\$0	\$0	
Rebates/Incentives (\$ over remedy lifetime)	NA	NA	\$0	
Total Cost of Option (\$ over remedy lifetime)	\$22,506	\$7,861		
Remedy Lifetime Cost Reduction	NA	\$14,645		
Return on Investment	NA	186%		
Simple Payback Period	NA	0 years		
Total Value of Renewable Post Remediation		\$0		
Sustainability Impacts				
Emissions (Life-Cycle)				
NOx (tons)	17	0	Negligible	Negligible
SOx (tons)	48	0	Negligible	Negligible
CO2 (tons)	18,719	0	0.00	1.43
RECs	0	0	0	37

#### Output Data Sheet


## 20 GPM\_No GAC




  <b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>PROJECT NOTE</b>	<b>TASK ORDER</b> <b>0300</b>
		<b>PROJECT NO.</b> <b>420005</b>
	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-003</b>  <b>CDRL B008</b>	<b>PAGE 1 OF 4</b>

Confirmation Of: <input type="checkbox"/> Meeting <input type="checkbox"/> Change Notice <input checked="" type="checkbox"/> General Project Note	Date Held: 26 April 2012 Location: IRP Conference Room Date Issued: 21 June 2012 Recorded By: Mark Hilyard
Subject: <b>FS-12 2011 ANNUAL SPEIM DATA PRESENTATION</b> <b>(MAY 2010 THROUGH NOVEMBER 2011)</b>	Issued By: Nigel Tindall  <hr/> CH2M HILL TECHNICAL SERVICES GROUP MANAGER


ITEM	REMARKS
<b>1.0</b>	<b>INTRODUCTION</b>  <p>This project note summarizes the Fuel Spill-12 (FS-12) 2011 annual data presentation for data collected under the FS-12 System Performance and Ecological Impact Monitoring (SPEIM) program between May 2010 and November 2011. The data presented include results from the following events:</p> <ul style="list-style-type: none"> <li>• Biennial sampling of 12 monitoring wells (September 2011)</li> <li>• Annual sampling of 24 monitoring wells (September 2011)</li> <li>• Semiannual sampling of 4 operating extraction wells (December 2010/September 2011)</li> <li>• Monthly sampling of treatment plant influent port (May 2010 through November 2011)</li> <li>• Groundwater vertical profiling at one location (November 2011)</li> </ul> <p>A summary of the data from these sampling events was presented to the regulatory agencies during the 26 April 2012 Technical Update meeting. The data presentation is included as Attachment A.</p>
<b>2.0</b>	<b>BACKGROUND</b>  <p>The FS-12 plume is defined by groundwater containing the contaminant of concern (COC) ethylene dibromide (EDB) at concentrations above the Massachusetts Maximum Contaminant Level (MMCL) of 0.02 micrograms per liter (µg/L). Benzene is also a COC at FS-12; however, this compound has not been detected in the FS-12 monitoring network at concentrations above the Maximum Contaminant Level (MCL) of 5 µg/L since 2006. The FS-12 plume is being remediated through the operation of the FS-12 extraction, treatment, and reinjection (ETR) system. During this reporting period, the ETR system operated using pumping configuration 2008 Scenario 01 through 18 August 2010. After that date, the ETR system was optimized to pumping configuration 2010 Scenario 01, which reduced the number of operating reinjection wells from 20 to 12 and adjusted reinjection rates at the remaining reinjection wells. Under 2010 Scenario 01, the FS-12 ETR system extraction rate remains unchanged with four extraction wells operating at a total flow rate of 360 gallons per minute (AFCEE 2010).</p>


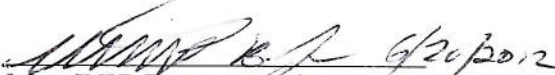
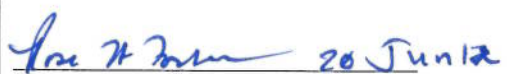
	<b>PROJECT NOTE</b>	TASK ORDER 0300
		PROJECT NO. 420005
<b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-003</b>  <b>CDRL B008</b>	PAGE 2 OF 4

ITEM	REMARKS
	<p>Analytical data for the FS-12 plume and ETR system have been collected through the SPEIM program since system startup in 1997. This program was developed to monitor plume changes and to ensure the effective operation of the groundwater remediation systems; monitoring networks are also evaluated and optimized through the SPEIM program. The current approved FS-12 SPEIM monitoring network, including analytical scope and methods, is presented in the <i>Comprehensive Long Term Monitoring Plan</i>, which is available from the Air Force Center for Engineering and the Environment (AFCEE).</p>
<b>3.0</b>	<p><b>RESULTS</b></p> <p>Analytical results for FS-12 were presented for select monitoring wells located within and in the vicinity of the FS-12 plume. The results of the 2011 sampling events were provided with previous results for comparison purposes (Attachment A). Trend analysis was presented using EDB concentration trend plots for key monitoring wells located throughout the plume (Figure 7 of Attachment A). In addition, the groundwater vertical profiling results for EDB at 90DP1008, which was advanced adjacent to existing monitoring well 90DP0008, were presented. Lastly, updated cross section depictions of the FS-12 plume were presented (Figures 2, 3, 4, and 5 of the Attachment A).</p> <p>An overview of ETR system operations during the reporting period was presented by providing extraction well and treatment plant influent EDB concentrations, estimates of EDB mass removal, number of carbon changes, and extraction well operational flow rates. Note that all the analytical data collected in 2010 for the FS-12 SPEIM program were included in the <i>Fuel Spill-12 2010 Summary Letter Report</i>, which was submitted in March 2011 (AFCEE 2011) and all the analytical data collected in 2011 were included in the <i>Fuel Spill-12 2011 Summary Letter Report</i>, which was submitted in March 2012 (AFCEE 2012).</p>
<b>4.0</b>	<p><b>ANNUAL DATA PRESENTATION CONCLUSIONS</b></p> <p>The following conclusions were presented based on the evaluation of the data collected under the SPEIM program:</p> <ul style="list-style-type: none"> <li>• SPEIM data collected during the reporting period indicate that the selected remedy for the FS-12 plume continues to meet the remedial objectives for the system (i.e., plume containment). <ul style="list-style-type: none"> <li>○ No EDB was detected in monitoring wells located downgradient of the ETR system.</li> <li>○ EDB concentrations at plume boundary wells are either consistent or lower than previous sampling results.</li> </ul> </li> <li>• Groundwater monitoring data and the vertical profiling results from 90DP1008 indicate that EDB concentrations in the plume to the north of 90EW0019 and within the hydraulic capture zone of 90EW0031 continue to decrease.</li> </ul>

	<b>PROJECT NOTE</b>	TASK ORDER 0300
		PROJECT NO. 420005
<b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> <b>Otis ANG Base, Massachusetts</b> <b>4P08 FA8903-08-D-8769-0300</b>	<b>DOCUMENT CONTROL NUMBER:</b> <b>420005-SPEIM-FS12-PRJNOT-003</b>  <b>CDRL B008</b>	PAGE 3 OF 4

ITEM	REMARKS
	<ul style="list-style-type: none"> <li>Highest EDB concentrations (21.4 µg/L at 90MW0206B) remain in the core of the plume that is located between 90EW0019 and the Southern Toe extraction fence.</li> <li>SPEIM data indicate that the trailing edge of FS-12 is in the vicinity of off-line extraction well 90EW0014. Therefore, the plume boundary should be updated.</li> <li>No changes to the existing private well Land Use Control (LUC) area for FS-12 area are warranted.</li> </ul>
<b>5.0</b>	<b>RECOMMENDATIONS/PATH FORWARD</b> <ul style="list-style-type: none"> <li>Continue to operate the FS-12 ETR system using the 2010 Scenario 01 pumping configuration.</li> <li>Continue to monitor the FS-12 plume using the current SPEIM monitoring network.</li> <li>Update the EDB plume boundary as depicted in Figure 8 of the data presentation (Attachment A).</li> <li>Continue with the private well verification within the established LUC area for the FS-12 plume.</li> <li>Identify future opportunities to optimize the operation of the FS-12 ETR system.</li> </ul>
<b>6.0</b>	<b>REGULATOR COMMENTS/ACTION ITEMS</b> <p>No comments on the data presentation were received from the U.S. Environmental Protection Agency (EPA) at the time of the data presentation on 26 April 2012. The Massachusetts Department of Environmental Protection (MassDEP) asked if there was an adequate monitoring network located downgradient of the Southern Toe extraction fence. AFCEE reiterated that the existing monitoring wells used to monitor the aquifer downgradient of the ETR system are screened appropriately to monitor the aquifer downgradient of the Southern Toe extraction fence. No additional comments were received during the 26 April 2012 Technical Update meeting. A follow-up with the regulatory agencies was conducted during the next Technical Update meeting (20 June 2012) and no additional comments were received at that time and no action items were identified.</p>
<b>7.0</b>	<b>REFERENCES</b> <p>AFCEE 2012 (March). <i>Fuel Spill-12 2011 Summary Letter Report</i>. 420005-SPEIM-FS12-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.</p> <p>_____. 2011 (March). <i>Fuel Spill-12 2010 Summary Letter Report</i>. 404929-SPEIM-FS12-SLR-001. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA.</p>

 <b>CH2MHILL</b>	<b>PROJECT NOTE</b>	TASK ORDER 0300
		PROJECT NO. 420005
<b>AFCEE</b> <b>SPEIM/LTM/O&amp;M</b> Otis ANG Base, Massachusetts 4P08 FA8903-08-D-8769-0300	DOCUMENT CONTROL NUMBER: 420005-SPEIM-FS12-PRJNOT-003 CDRL B008	PAGE 4 OF 4

ITEM	REMARKS
	<p>_____. 2010 (September). <i>Fuel Spill-12 2010 Extraction, Treatment and Reinjection System Optimization</i>. 389849-SPEIM-FS12-PRJNOT-003. Prepared by CH2M HILL for AFCEE/MMR, Installation Restoration Program, Otis Air National Guard Base, MA</p>
8.0	<p><b>CONCURRENCE</b></p> <p>Concurrence with the updated FS-12 EDB plume boundary is represented by the signatures below:</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">             U.S. EPA Representative         </div> <div style="text-align: center;">             MassDEP Representative         </div> </div> <div style="margin-top: 20px;">             AFCEE Project Manager         </div> <p>Note: The parties involved will retain the ability to modify the FS-12 plume boundary based on field observations or other mutually agreeable technical justifications.</p>

Attachment:

Attachment A: FS-12 2011 Annual SPEIM Data Presentation, 26 April 2012 Technical Update Meeting

## **ATTACHMENT A**

# **FS-12 2011 Annual SPEIM Data Presentation**

## **26 April 2012 Technical Update Meeting**

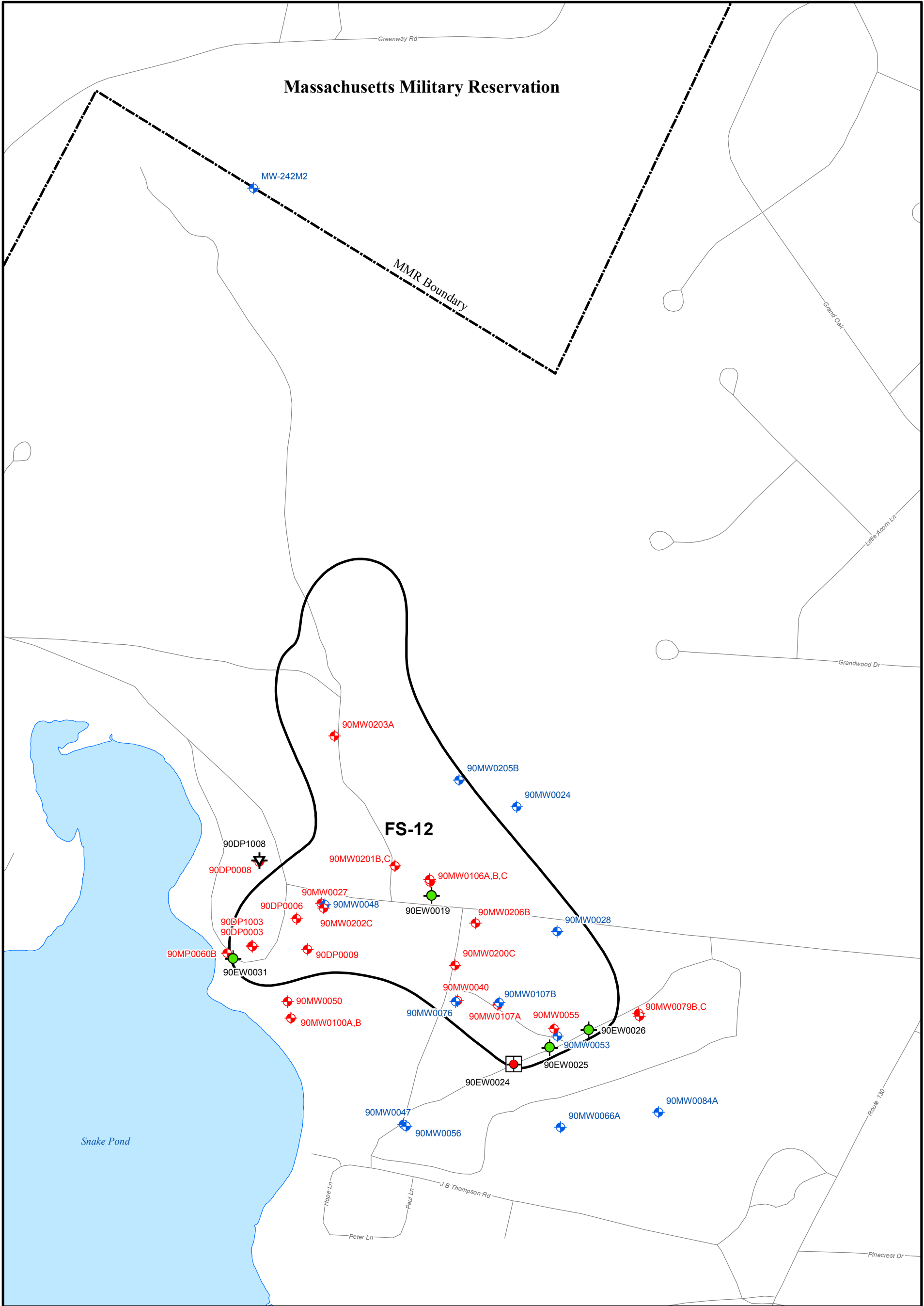
### **Overview**

- Reporting Period: May 2010 through November 2011
- SPEIM network optimized (July 2011)
- Sampling locations and plume boundary (Figure 1):
  - Biennial sampling of 12 monitoring wells (September 2011)
  - Annual sampling of 24 monitoring wells (September 2011)
  - Semiannual sampling of 4 operating extraction wells (December 2010 and September 2011)
  - Monthly sampling of treatment plant influent (May 2010 through November 2011)
  - Groundwater vertical profiling at 90DP1008 (November 2011)

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**Overview (cont.)**

- Review groundwater and ETR system performance monitoring data
- Update on EDB degradation research and pilot test
- Deviation - 90DP0008 could not be sampled due to an obstruction in the well
  - Replacement well, 90MW0209A, installed in March 2012



**FIGURE 1**

**FS-12 CHEMICAL MONITORING NETWORK AND DIRECT PUSH LOCATIONS**

AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

# **FS-12 2011 Annual SPEIM**

## **Data Presentation**

**26 April 2012 Technical Update Meeting**

### **Highlights of Data Review**

- Base boundary well (Figure 1)
  - MW-242M2 ND; down from BRL in 2009
- Eastern plume boundary (Figure 1)
  - EDB concentrations at:
    - 90MW0205B: 0.051 µg/L (down from vertical profile result of 0.171 µg/L in March 2010)
    - 90MW0024 remains ND
    - 90MW0028: 0.11 µg/L up from BRL in 2008
    - 90MW0079B,C remain ND
- Western plume boundary
  - EDB concentrations at:
    - 90MP0060B cluster: 0.021 similar to 0.028 µg/L in December 2010
    - 90MW0050; 90MW0100A,B; and 90EW0024 remain ND

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**Highlights of Data Review (cont.)**

- Vertical Profiling at 90DP1008 (adjacent to 90DP0008)
  - 90DP0008 was obstructed; therefore, this well was abandoned.
  - Groundwater vertical profiling conducted at 90DP1008; and installation of a new small-diameter monitoring well (90MW0209A) completed in November 2011.
  - Vertical profiling results indicate that remaining EDB is shallower in aquifer and lower concentrations than what was characterized during advancement of 90DP0008 in 2004.

**Technical Update meeting - 26 April 2012**  
**Borehole Groundwater Screening Results**  
**Direct Push Location 90DP1008/90MW0209A**  
**(Adjacent to former 90DP0008)**

90DP0008 (2004)

Date Sampled	Sample Interval	Depth TOS (ft bgs)	Depth BOS (ft bgs)	Mid-Depth (ft bgs)	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02	Mid-Depth (ft msl)	EDB (µg/L) MMCL = 0.02
11/22/2011	A	100	105	102.5	10.1	ND	11	ND
11/22/2011	B	110	115	112.5	0.1	ND	1	ND
11/22/2011	C	120	125	122.5	-9.9	ND	-9	ND
11/28/2011	D	130	135	132.5	-19.9	ND	-19	ND
11/28/2011	E	140	145	142.5	-29.9	ND	-29	BRL
11/28/2011	F	150	155	152.5	-39.9	<b>0.039</b>	-39	<b>0.056</b>
11/28/2011	G	160	165	162.5	-49.9	<b>0.342</b>	-49	<b>0.173</b>
11/28/2011	H	170	175	172.5	-59.9	<b>0.042</b>	-59	<b>0.294</b>
11/28/2011	I	180	185	182.5	-69.9	ND	-69	<b>0.739</b>
11/30/2011	J	190	195	192.5	-79.9	ND	-79	<b>1.04</b>
11/30/2011	K	200	205	202.5	-89.9	ND	-89	<b>0.086</b>
12/1/2011	L	210	215	212.5	-99.9	ND	-99	0.013
		220	225	222.5	-111.5	NS	-105	<b>0.052</b>

Key:

BOS = bottom of sample

BRL = below reporting limit (0.01 µg/L)

EDB = Ethylene Dibromide

ft bgs = feet below ground surface

ft msl = feet mean sea level

MMCL = Massachusetts Maximum Contaminant Level

ND = not detected

TOS = top of sample

µg/L = micrograms per liter


Notes:


Approximate elevation of ground surface is 112.6 ft msl.

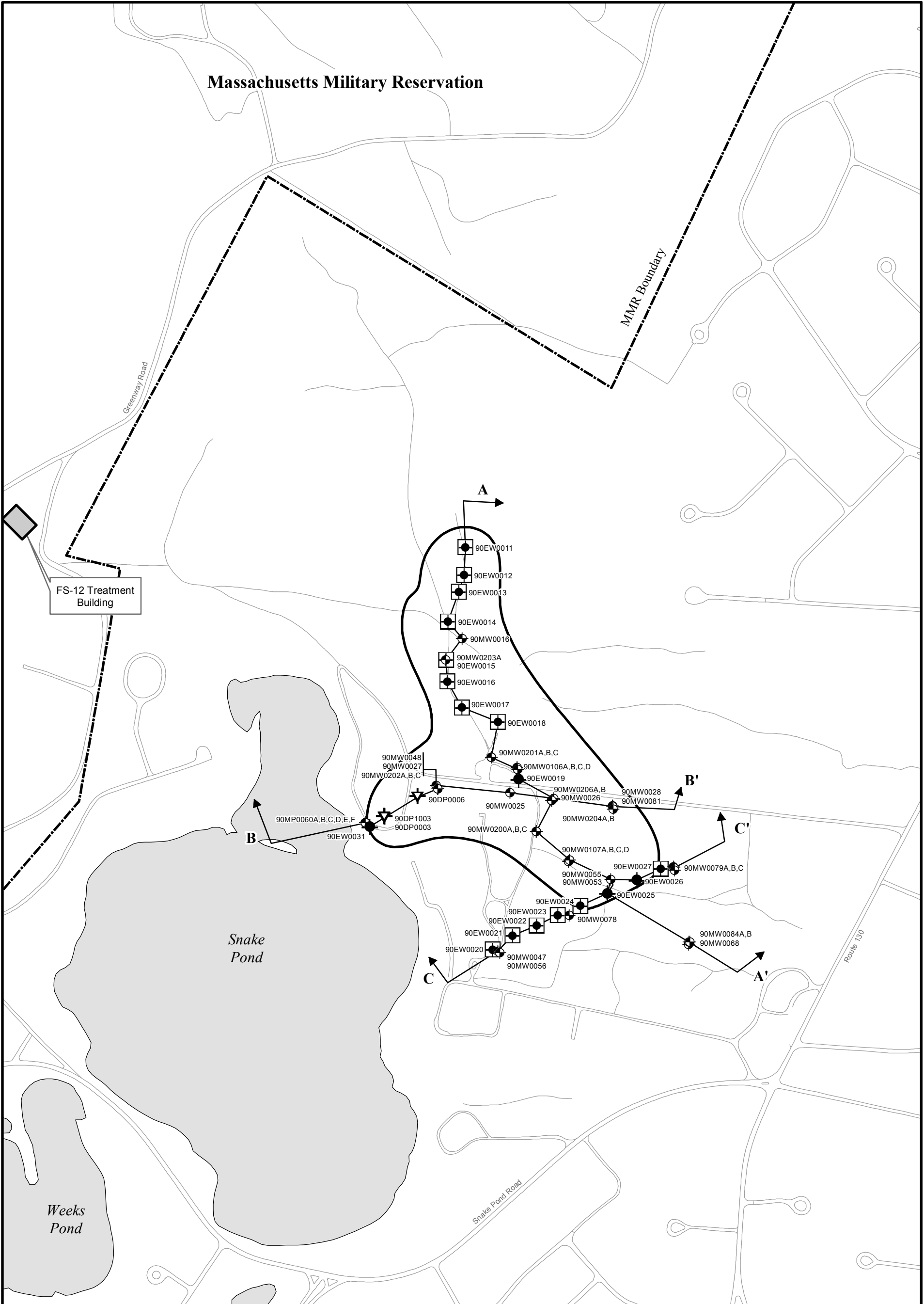
First sampling interval was 100 ft bgs.

Bold indicates concentration exceeds the MMCL.

Boring refusal at 90DP1008 was encountered at 215 ft bgs (-104.5 ft msl).

 - screened interval for 90MW0209A

 - screened interval for 90DP0008



Legend

- Monitoring Well
- Extraction Well
- Extraction Well (Off)
- Direct Push

- Current Plume Boundary
- MMR Boundary

Data Source: AFCEE, April 2012, MMR-AFCEE Data Warehouse  
 MMR Boundary from Massachusetts Air National Guard 2011

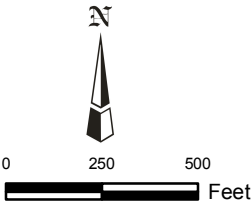
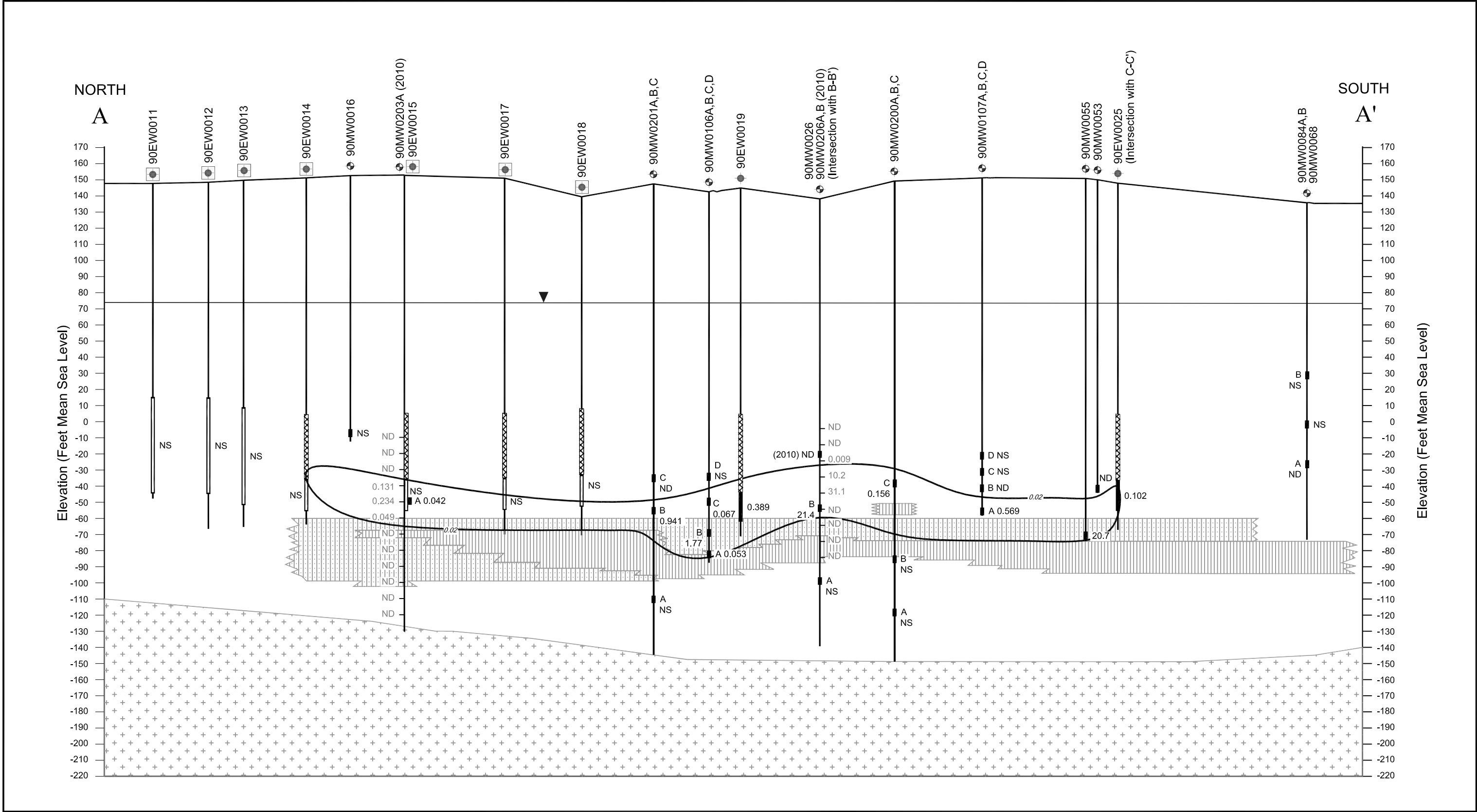


FIGURE 2

CROSS-SECTION LINES AT FS-12

AFCEE - Massachusetts Military Reservation  
 26 April 2012 Technical Update Meeting



**FIGURE 3**  
**FS-12 EDB CROSS SECTION A-A'**  
AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

V: 58  
H: 252  
0 Feet

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26 April 2012 Technical Update Meeting**

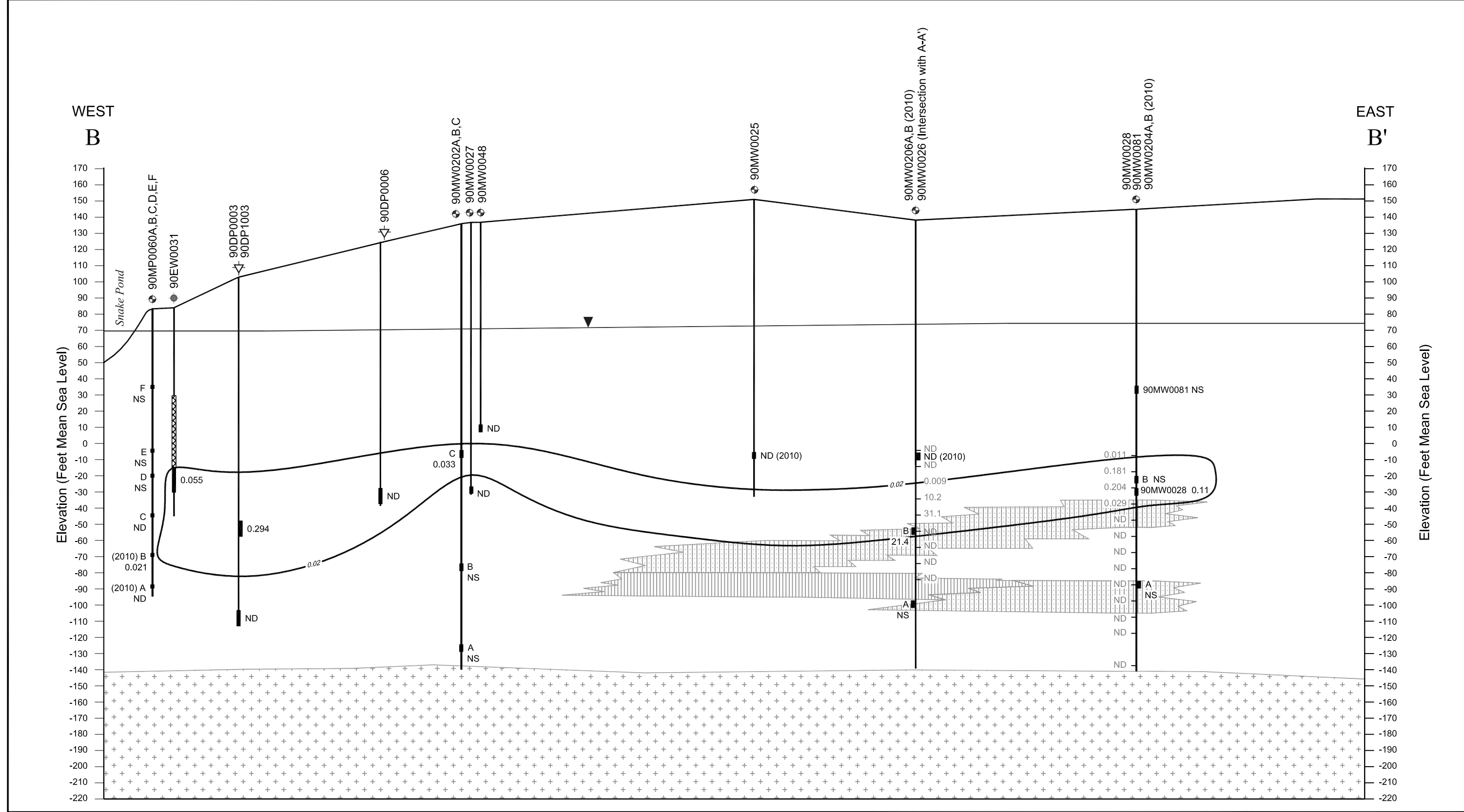
**Highlights of Data Review (cont.)**

- Plume monitoring north of 90EW0019 (Cross-Section A-A' & Figure 1)
  - EDB concentrations north of 90EW0019 continue to decline.
    - 90MW0203A: 0.042 µg/L; down from 0.234 µg/L (vertical profile result from March 2010)
    - 90MW0201B: 0.941 µg/L; down from 2.17 µg/L in December 2010
    - 90MW0201C: Remains ND
    - 90MW0106A: 0.053 µg/L; down from 0.236 µg/L in December 2010
    - 90MW0106B: 1.77 µg/L; down from 5.01 µg/L in December 2010
    - 90MW0106C: 0.067 µg/L; down from 0.86 µg/L in December 2010




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**Highlights of Data Review (cont.)**

- Plume monitoring between 90EW0019 and southern toe extraction fence
  - Greatest EDB concentrations along axis of plume in this area; concentrations are generally decreasing at periphery wells
    - 90MW0206B: 21.4 µg/L; new monitoring well installed in 2010
    - 90MW0055: 20.7 µg/L; consistent with past results
    - 90MW0040: 0.891 µg/L; down from 1.21 µg/L in December 2010
    - 90MW0107A: 0.569 µg/L; down from 1.22 µg/L in December 2010
- South of southern toe extraction fence
  - EDB remains ND at all monitoring wells.




Legend

- |   |                 |
|---|-----------------|
|  | Monitoring Well |
|  | Extraction Well |
|  | Water Table     |
| ND  | Nondetect       |

NS      Not Sampled

0.043 EDB Data (µg/L)  
Collected in September 2011  
Unless Otherwise Noted

 Packer Well Screen

Well Screen ID

—0.02— EDB Isoconcentration  
Contour (MMCL = 0.02 µg/L)

1.2 | EDB Vertical Profile Data (µg/L)  
(Date Noted)



Bedrock

 Silt

Silty Sand

Data Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

**FIGURE 4**

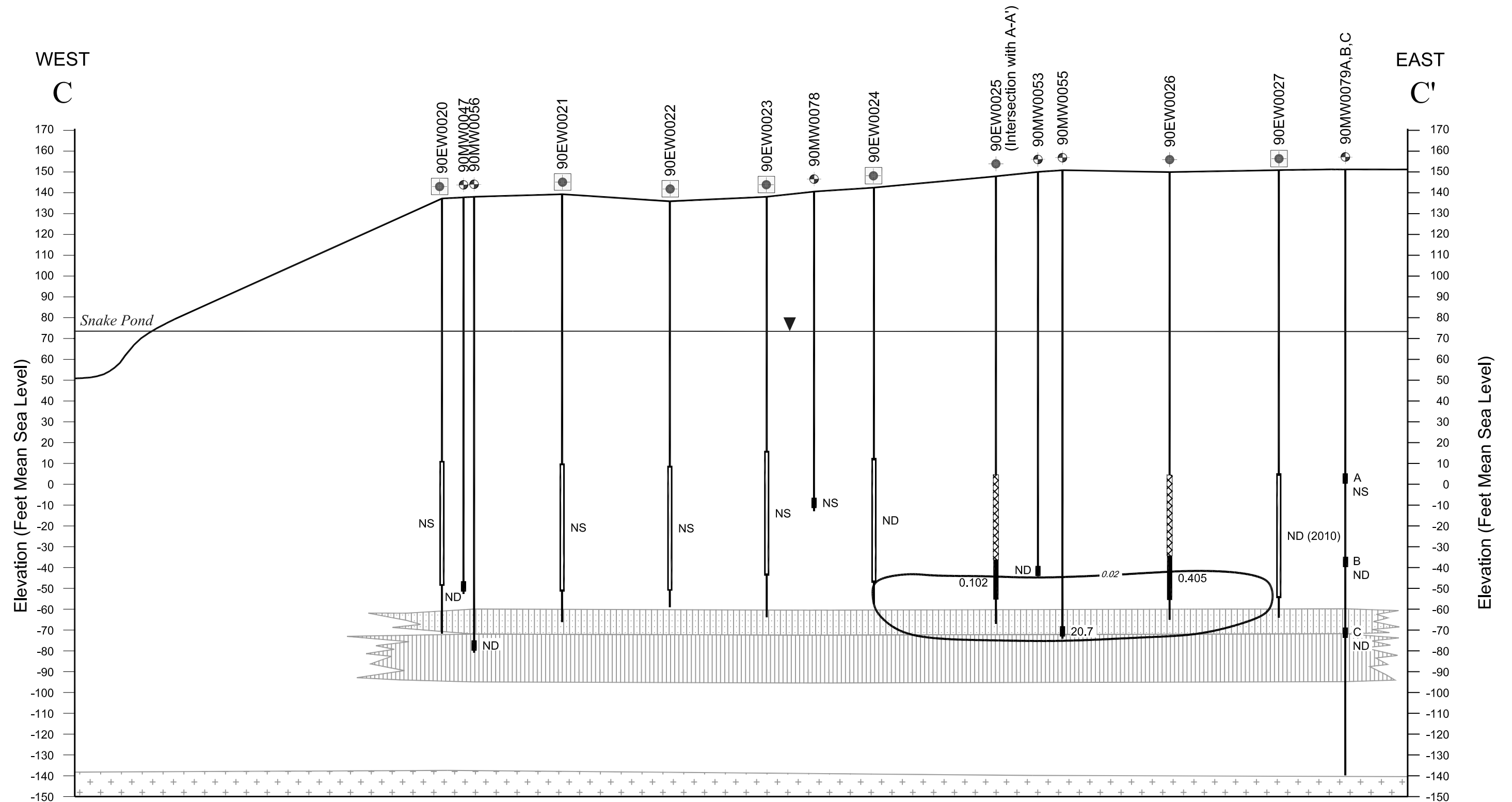
**FS-12 EDB CROSS SECTION B-B'**

AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

V: 58  
H: 143








0 H: 143  
Feet

**—CH2MHILL®—**



Data Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse.

Legend

- |   |                       |   |             |  |   |                |   |      |   |            |
|---|-----------------------|---|-------------|--|---|----------------|---|------|---|------------|
|  | Monitoring Well       | NS  | Not Sampled |  | A | Well Screen ID |  | Silt |  | Bedrock    |
|  | Extraction Well (On)  |  | 0.36        |  |   | 0.02           | EDB Isoconcentration Contour (MMCL = 0.02 µg/L)                                       |      |   |            |
|  | Extraction Well (Off) | EDB Data (µg/L)<br>Collected in September 2011<br>Unless Otherwise Noted            |             |  |   |                |   |      |   |            |
|  | Water Table           |  |             |  |   | 1.2            | EDB Vertical Profile Data (µg/L)<br>(Date Noted)                                      |      |  | Silty Sand |
| ND  | Nondetect             |   |             |  |   |                |   |      |   |            |

**FIGURE 5**

**FS-12 EDB CROSS SECTION C-C'**

AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

V: 48  
H: 130

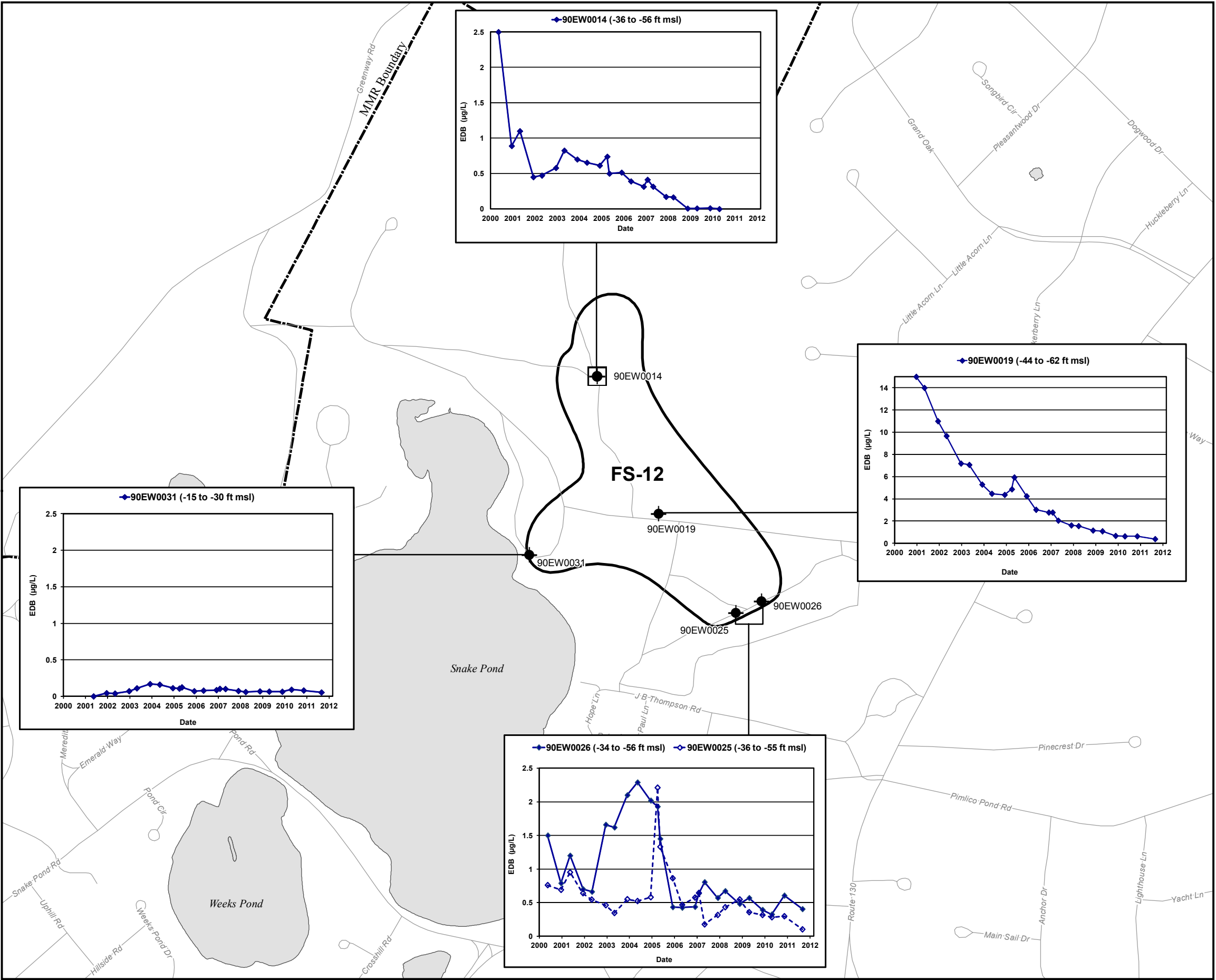
0 H: 130  
Feet

**- CH2MHILL® -**

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**Highlights of Data Review (cont.)**

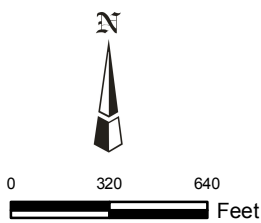
- Plume monitoring near 90EW0031 (Cross Section B-B' & Figure 1)
  - EDB concentrations continue to decrease in vicinity of 90EW0031
    - 90MW0202C: 0.033 µg/L; down from 0.041 µg/L in December 2010
    - 90DP0009: 0.077 µg/L; consistent with past results
    - 90DP0006: ND; down from 0.149 µg/L in December 2010
    - 90DP1003: 0.294 µg/L; down from 0.627 in December 2010
- Highest EDB concentrations are south of 90EW0019, along axis of plume



Legend

- Extraction Well (On)
- Extraction Well (Off)
- Plume Boundary
- Massachusetts Military Reservation Boundary

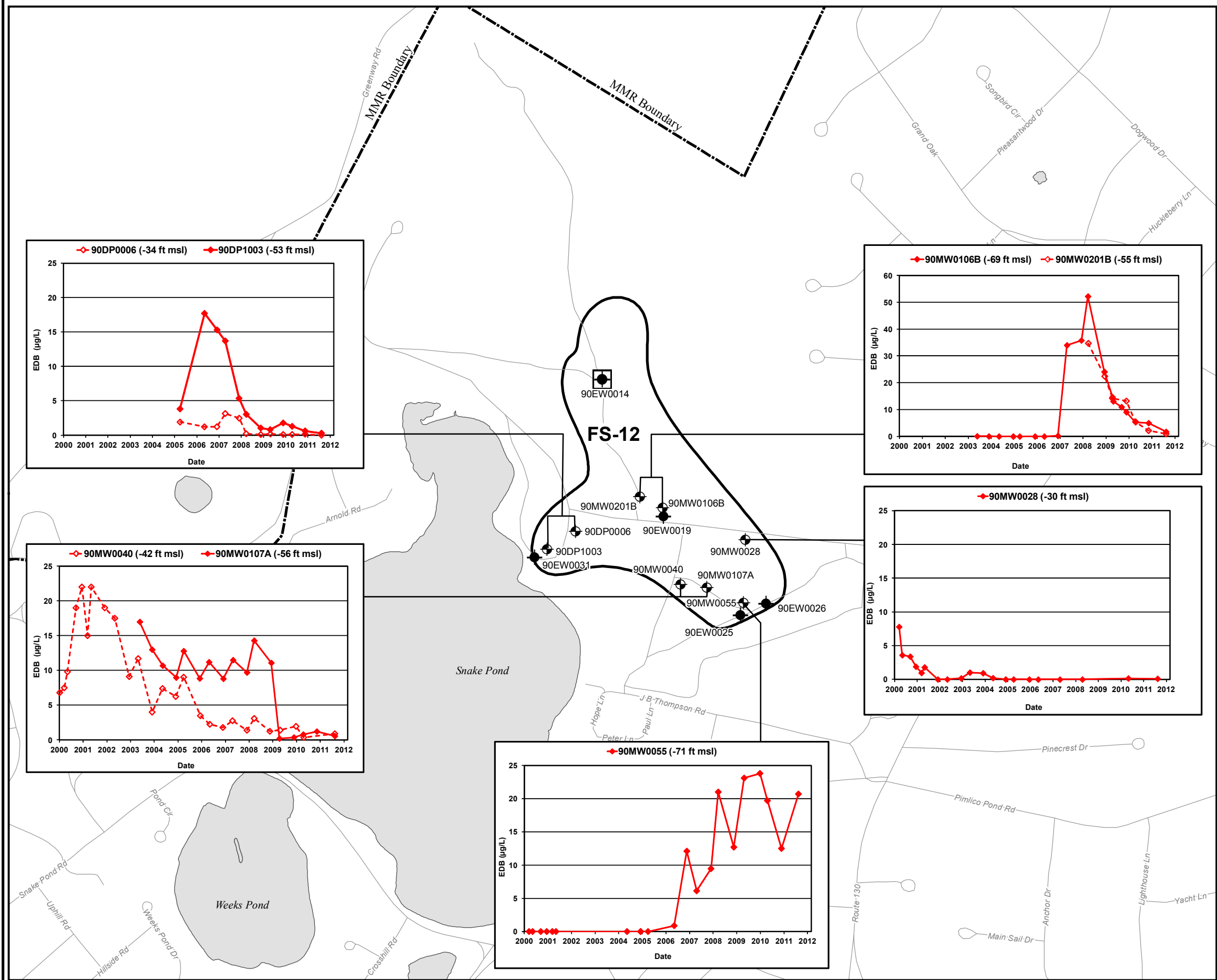
**Note:**  
Value in parentheses after Loc ID on graphs represents the screen elevation in feet mean sea level (ft msl)



Data Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

FIGURE 6

**EDB CONCENTRATION TRENDS AT  
SELECTED EXTRACTION WELLS**  
AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

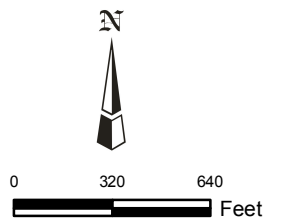


### Legend

- Monitoring Well
- Extraction Well (On)
- Extraction Well (Off)
- Plume Boundary
- Massachusetts Military Reservation Boundary

### Note:

Value in parentheses after Loc ID on graphs represents the mid-screen elevation in feet mean sea level (ft msl)



Data Source: AFCEE, January 2012, MMR-AFCEE Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

**FIGURE 7**

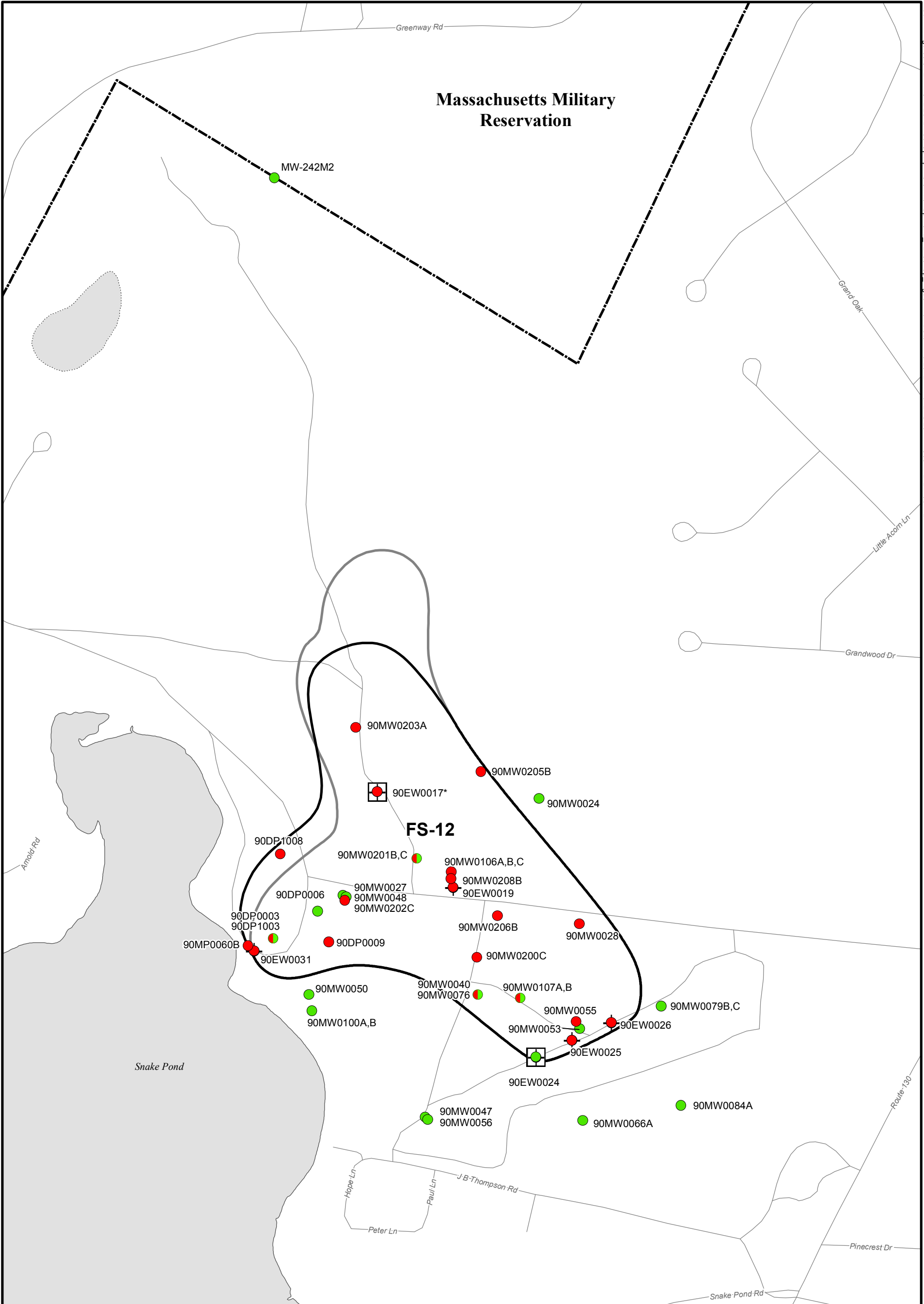
## EDB CONCENTRATION TRENDS IN SELECTED FS-12 MONITORING WELLS

AFCEE - Massachusetts Military Reservation  
26 April 2012 Technical Update Meeting

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**Highlights of Data Review (cont.)**

- Extraction well sampling and trends (Figure 6)
  - 90EW0019: 0.389 µg/L; down from 0.638 µg/L in December 2010
  - 90EW0031: 0.055 µg/L; down from 0.082 µg/L in December 2010
  - 90EW0025: 0.102 µg/L; down from 0.297 µg/L in December 2010
  - 90EW0026: 0.405 µg/L; down from 0.606 µg/L in December 2010
- EDB trends throughout plume (Figure 7)
  - Decreasing trends at monitoring wells located north of 90EW0019 and east of 90EW0031
  - Greatest EDB concentrations located south of 90EW0019, along longitudinal axis of plume



Path: X:\Figures\SP\EMFS12\2012\TechUp\04\GIS\Acomp\FS12\_12\TechUp\_Fig08.mxd Date: 4/19/2012 Time: 2:45:28 PM User: 1272479611E

Legend

- 2011 Plume Boundary
- Former Plume Boundary
- Massachusetts Military Reservation Boundary
- Bog/Wetland
- Extraction Well (On)
- Extraction Well (Off)

EDB Detections in Groundwater:

- No Detection
- Detection Above MMCL

Data Source: AFCEE, March 2012, MMR-AFCEE Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

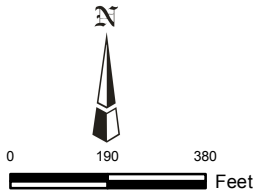


FIGURE 8

FS-12 2011 EDB DETECTIONS IN GROUNDWATER AND NEW PLUME BOUNDARY

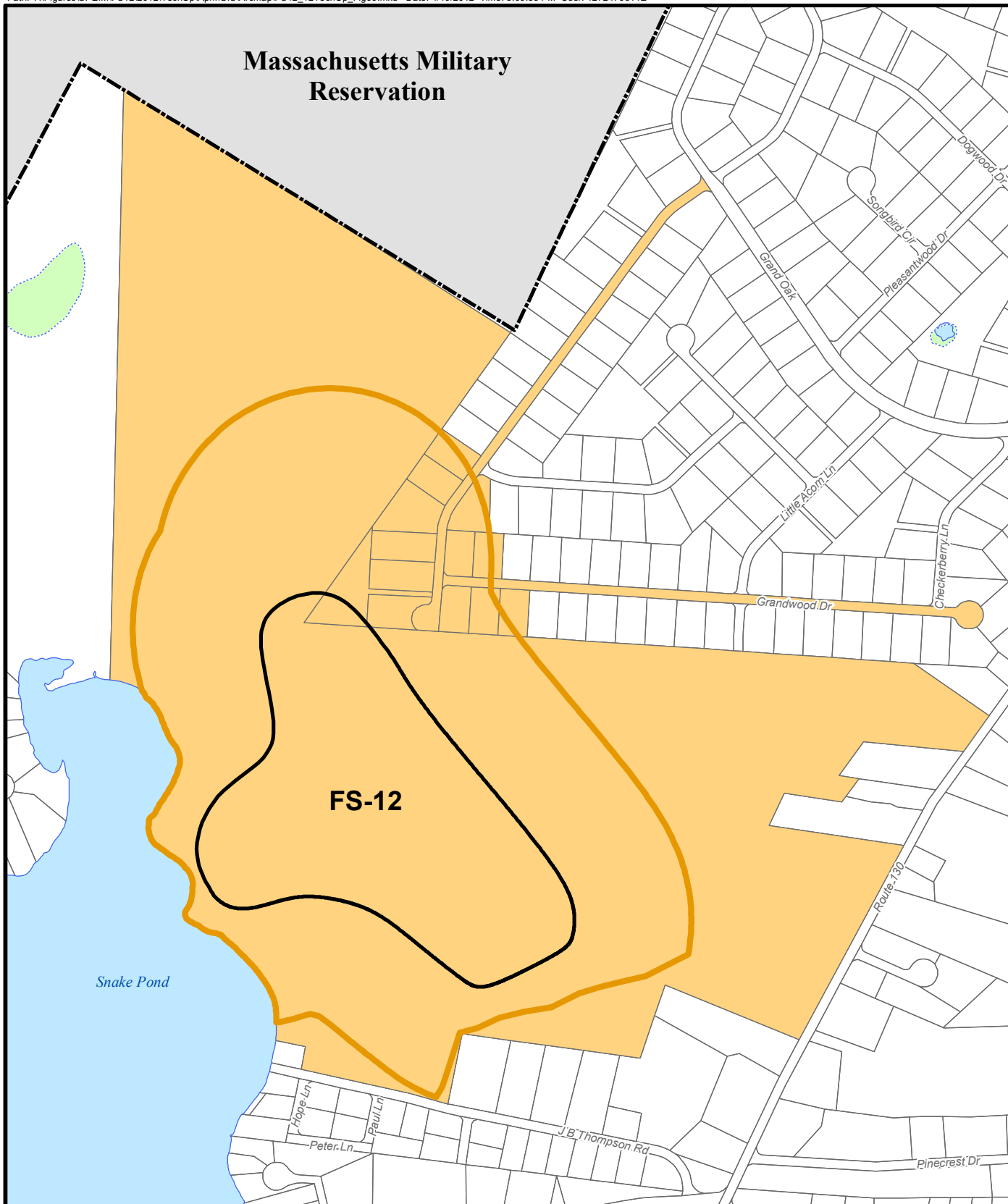
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26 April 2012 Technical Update Meeting

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Data Presentation  
26 April 2012 Technical Update Meeting**

**Highlights of Data Review (cont.)**

- New FS-12 plume boundary (Figure 8)
  - Trailing edge in vicinity of 90EW0014
  - Western plume boundary expanded to include 90DP1008
  
- No changes to FS-12 Land Use Control Area (Figure 9)

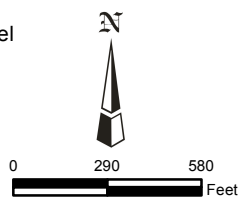


Data Source: AFCEE, MMR-AFCEE Data Warehouse  
MMR Boundary from Massachusetts Air National Guard 2011

### Legend

- Massachusetts Military Reservation Boundary
- Plume Boundary
- Land Use Control Boundary

- FS-12 LUC Parcel
- Bog/Wetland



### FIGURE 9

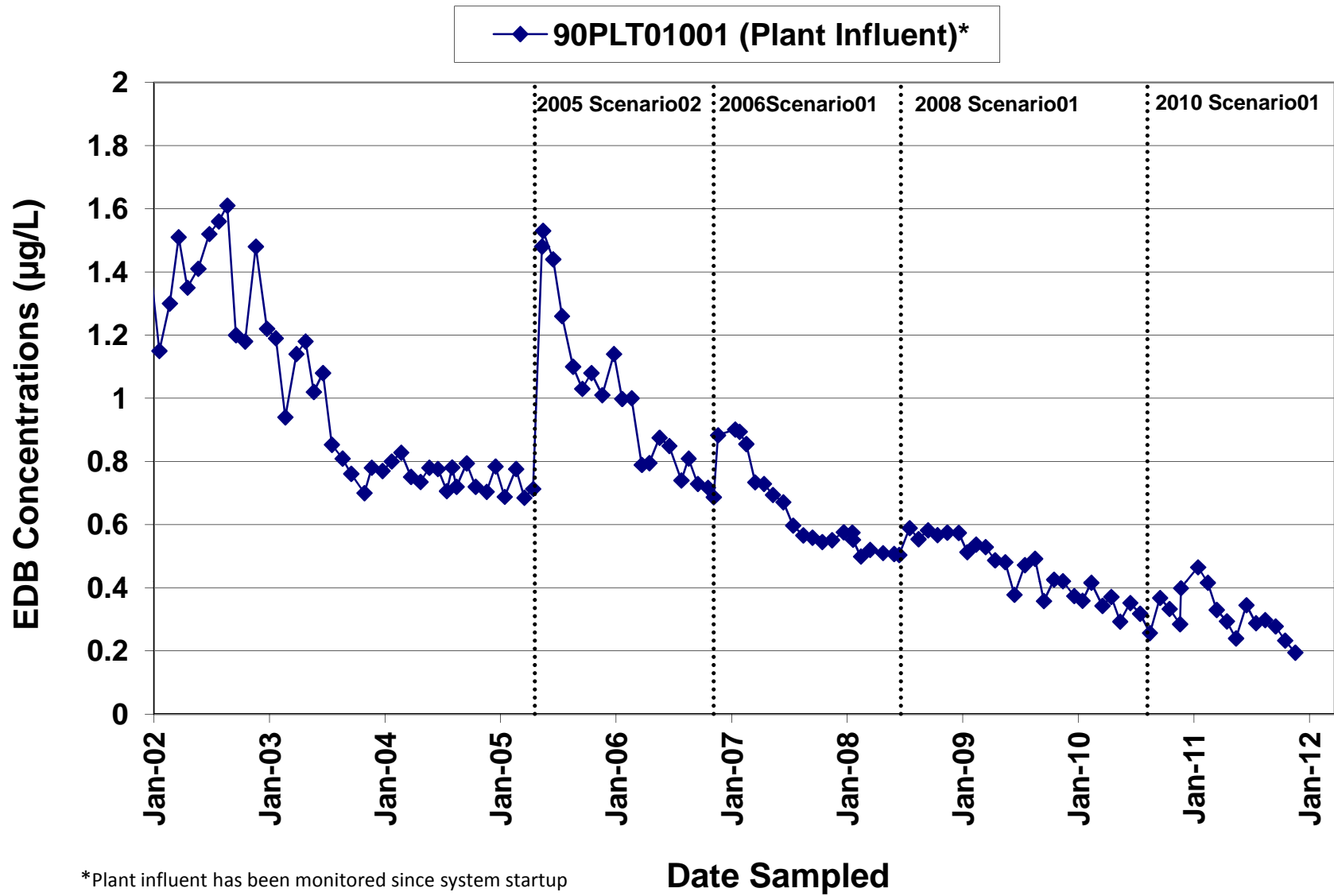
**FS-12 LAND USE CONTROL**  
AFCEE - Massachusetts Military Reservation  
12 April 2012 Technical Update Meeting

# **FS-12 2011 Annual SPEIM Data Presentation**

## **26 April 2012 Technical Update Meeting**

### **ETR System Summary (May 2010 through November 2011)**

- ETR system pumping configurations
  - 2008 Scenario 01 through 18 August 2010
  - 2010 Scenario 01 after 18 August 2010
    - Reconfiguration of reinjection rates, no change to extraction rates.
- 283 million gallons of groundwater treated by ETR system
- 0.74 pounds of EDB removed; 135.7 pounds since system startup
- Plant influent EDB concentrations ranged from 0.465 to 0.195 µg/L
- 3 carbon exchanges
- Most extraction wells operated at 92%-98% design rates
  - 90EW0025 slightly lower at 88%, however, flow increased to 90% design flow rate after well maintenance in June 2011.



\*Plant influent has been monitored since system startup in 1997, data since 2002 shown to focus on recent data trends.

# **FS-12 2011 Annual SPEIM Data Presentation**

**26 April 2012 Technical Update Meeting**

## **ETR System Summary (May 2010 through November 2011)**

- EDB Mass Removed by ETR system = 0.74 lbs
- ETD system used 1,443 MWh of electricity
- Estimated VOC mass emitted to air assuming traditional New England power mix = 71 lbs
- Estimated VOC mass emitted to air considering contributions from AFCEE wind turbine and green power purchases = 36 lbs

**FS-12 Remedial System Electrical Consumption and Associated Air Emissions**  
**FS-12 2011 Annual SPEIM Data Presentation**  
**26 April 2012 Technical Update Meeting**

		05/1/2010 to 11/30/2011	System Startup (9/1997) to 11/30/2011
Volume of Groundwater Treated (million gallons)		283	4,424
Groundwater COC Mass Removal (pounds)		0.74	192.60
Electrical Usage (MWh)		1,443	21,079
Estimated Air Emissions <sup>1</sup> (based on electrical usage)	CO <sub>2</sub> (tons)	945	17,268
	NO <sub>x</sub> (lbs)	2,035	26,914
	PM-10 (lbs)	116	985
	SO <sub>2</sub> (lbs)	5,426	29,843
	VOCs (lbs)	71	1,259
Estimated Reduction in Air Emissions due to Green Power Purchases <sup>2</sup>	CO <sub>2</sub> (tons)	174	509
	NO <sub>x</sub> (lbs)	375	1,019
	PM-10 (lbs)	21	54
	SO <sub>2</sub> (lbs)	1,000	2,387
	VOCs (lbs)	13	38
Estimated Reduction in Air Emissions due to MMR Wind Turbine Operation <sup>3</sup>	CO <sub>2</sub> (tons)	292	433
	NO <sub>x</sub> (lbs)	629	932
	PM-10 (lbs)	36.0	53.3
	SO <sub>2</sub> (lbs)	1,677	2485
	VOCs (lbs)	22.0	32.6
Estimated Total Air Emissions with consideration of Green Power Purchases and MMR Wind Turbine Operation	CO <sub>2</sub> (tons)	479	16,326
	NO <sub>x</sub> (lbs)	1,031	24,964
	PM-10 (lbs)	59	878
	SO <sub>2</sub> (lbs)	2,749	24,971
	VOCs (lbs)	36	1,189

Notes:

1) The estimated air emissions presented in this table are based on the assumption that until 4/30/2009, the power used to operate the MMR remedial systems was provided by the Mirant Canal Station power plant in Sandwich, MA. This power plant primarily produced electricity generated by the combustion of fuel oil and has been off-line since 5/1/2009. Starting on 5/1/2009, air emissions are based on electricity generated by the average mix of power sources in Massachusetts. Air emissions were calculated using MMR utility data from AFCEE's Metrix 4 Utility Accounting Software (<http://www.abraxasenergy.com/metrix4.php>) and emission factors obtained from the following websites:  
<http://www.csgnetwork.com/elecpowerpolcalc.html>  
<http://www.metrixcentral.com/EmissionsCalculator/Emissions%20Factors%202004.pdf>

2) Emissions offset by purchases of electricity from renewable sources beginning 7/1/2008.

3) Emissions offset by operation of AFCEE-owned wind turbines beginning on 12/2/2009 (Wind I) and 11/1/2011 (Wind II).

Key:

COC = contaminant of concern

CO<sub>2</sub> = carbon dioxide

FS-12 = Fuel Spill-12

lbs = pounds

MMR = Massachusetts Military Reservation

MWh = megawatt hours

NO<sub>x</sub> = nitrogen oxides

PM-10 = particulate matter with a diameter of 10 micrometers or less

SO<sub>2</sub> = sulfur dioxide

VOCs = volatile organic compounds

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**FS-12 EDB Biodegradation Studies and Pilot Test**

- Research by UMass Amherst and others on the enhanced biodegradation of EDB in microcosms (constructed from FS-12 aquifer materials) continued in 2011.
- Several potential amendments have been identified that may be used to stimulate the growth of EDB degraders in situ.
- A field-scale pilot test system, which can be used to test various amendments, has been partially installed at FS-12 (described at 17 November 2011 Technical Update Meeting).
- Work Plan for field pilot test has been submitted and field testing is expected to begin Summer 2012.
- Updates will be given at future Technical Update Meetings.

# **FS-12 2011 Annual SPEIM Data Presentation**

## **26 April 2012 Technical Update Meeting**

### **Conclusions – SPEIM Data Presentation**

- SPEIM data indicate that the FS-12 remedy continues to meet the remedial objectives for the system (i.e., plume containment).
- No EDB detected downgradient of the ETR system.
- EDB concentrations to north of 90EW0019 and within capture zone of 90EW0031 continue to decrease.
- Highest concentrations of EDB remain along the axis of the plume between 90EW0019 and the Southern Toe extraction fence.
  - EDB concentrations at 90MW0206B are expected to decrease slowly as this portion of the aquifer is likely a hydraulic stagnation zone between 90EW0019 and southern toe fence extraction wells.
- Historic extraction well influent data and recent groundwater monitoring data indicate that the trailing edge of FS-12 is in the vicinity of 90EW0014.

**FS-12 2011 Annual SPEIM  
Data Presentation  
26 April 2012 Technical Update Meeting**

**Recommendations and Path Forward**

- Continue to operate the ETR system using 2010 Scenario 01 pumping configuration (implemented August 2010)
- Continue to monitor the FS-12 plume using current SPEIM monitoring network
  - Next annual event is September 2012
- Update the FS-12 plume boundary
- Continue with private well verification program within FS-12 LUC area
- Field-scale pilot test of in-situ bioremediation of EDB is planned for area immediately upgradient of 90EW0019
- Identify future opportunities to optimize operation of the ETR system at FS-12